DEFENCE R&D DÉFENSE

# DEVELOPMENT OF ELVISS WORKSTATION

# ELVISS AIRBORNE HFE PROTOTYPE WORKSTATION SOFTWARE INTEGRATION AND TEST REPORT

December 23, 2002

National Defence Défense nationale

Canada

CMC ELECTRONICS INC.

# DEVELOPMENT OF ELVISS WORKSTATION

Contract No. W7711-017734/001/TOR
CMC Project EA0046

# ELVISS AIRBORNE HFE PROTOTYPE WORKSTATION SOFTWARE INTEGRATION AND TEST REPORT

**DRDC Toronto Report CR 2002-214**

December 23, 2002

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**CDRL 006**

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# EXECUTIVE SUMMARY

This report was prepared in support of the ELVISS Airborne HFE Prototype Workstation Project. This project was sponsored by DRDC Valcartier as part of a larger program to develop the Enhanced Low-light-level Visible and Infrared Surveillance System (**ELVISS**). The original Human Factors Engineering (**HFE**) rapid prototype, which was developed as part of an earlier tasking to CMC Electronics, used simple simulations of the sensor equipment to facilitate operator evaluation in a laboratory environment of the new Human Machine Interface (**HMI**). The primary objective of the current project is to convert the laboratory prototype into a flyable prototype workstation which could control the real equipment and be operated by Search And Rescue (**SAR**) Technicians under experimental flight test conditions.

The work related to the integration of the ELVISS Airborne HFE Prototype Workstation software with the various ELVISS subsystems is documented in this report, along with the results of the Ground and Flight Test activities which were carried out to further demonstrate and evaluate the system's potential to support SAR operations.

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# 1 INTRODUCTION

## 1.1 Background

The Department of National Defence (**DND**) has identified a requirement to enhance the capabilities of Search And Rescue (**SAR**) operators to conduct operations at night and under degraded weather conditions. Accordingly, the Defence Research and Development Canada (**DRDC**) Valcartier (formerly know as the Defence Research Establishment Valcartier or **DREV**) is developing a multi-sensor system composed of an active imaging system (the Airborne Laser-Based Enhanced Detection and Observation System (**ALBEDOS**)) and a thermal InfraRed (**IR**) imaging system. This system is identified as the Enhanced Low-light-level Visible and Infrared Surveillance System (**ELVISS**). In the initial version of ELVISS, the two sensors will be mounted separately on the aircraft (two turrets), but the output of both sensor systems will be controllable and viewable via a common interface. However, no integration of the images from the two sensors is planned at this time.

During the initial operational trials, ALBEDOS was demonstrated to have promising capabilities for use as a search and identification aid in the SAR mission, but was found to be difficult to employ by SAR aircrew. The DRDC - Toronto (formerly Defence and Civil Institute of Environmental Medicine (**DCIEM**)) conducted an evaluation of the ALBEDOS Human Machine Interface (**HMI**) and identified numerous deficiencies requiring resolution. DCIEM was requested to manage the development of an appropriate HMI for ALBEDOS in the SAR environment. In support of this request, DCIEM contracted CMC Electronics Inc. (**CMC**) to develop design concepts for an interface for ALBEDOS and to incorporate these concepts in a rapid prototype. The project was carried out by CMC in response to the Statement Of Work (**SOW**) entitled "Development of ALBEDOS Human-Machine Interface Concepts", issued under the Department of Supply and Services (**DSS**) Canada Contract Number W7711-6-7324/001/SRV. The Scientific Authority (**SA**) for the project was DCIEM.

Expert-user evaluation of the ALBEDOS rapid prototype, which was subsequently developed by CMC, showed that it was consistent with the requirements of the SAR operator and met with high user acceptance. Then in Sep 98, when DRDC Valcartier decided to add the infrared sensor, they came back to CMC for the workstation design changes. Under that contract, CMC designed, developed and implemented a rapid prototype for the dual sensor ELVISS, and evaluated it in a laboratory environment with both empirical and qualitative evaluation methods. Most recently, DRDC Valcartier decided to implement a flying prototype to further demonstrate and evaluate the system's potential to support SAR operations. CMC supported this activity, and this document reports the results of the associated integration and test effort.

The ELVISS HMI was implemented as a rapid prototype and evaluated in a laboratory environment with both empirical and qualitative evaluation methods. At this point, DRDC – Valcartier decided to implement a flying prototype to further demonstrate and evaluate the system's potential to support SAR operations. CMC supported this activity. This document reports the results of the integration and test effort carried out at the end of the flying prototype development project.

## 1.2 Development Overview

In Stage 1, development of the ELVISS Airborne HFE Prototype Workstation prototype software was focused on the 16 inch (") turret (comprised of a Thermal Imager (**TI**), a Laser Range Finder (**LRF**), , and a Day Colour Camera), three Digital Video Camera (**DVCAM**) recorders the POS/AV, the On-Screen menu of the Graphical User Interface (**GUI**), and display of grabbed video images from the Day Colour Camera and TI.

The original Stage 2 and Stage 3 prototype software design and integration efforts were eventually combined into a single stage "Stage 2/3" to minimize costs and maximize efficiency. During these combined stages, development of the ELVISS Airborne HFE Prototype Workstation prototype software was focused on the 24 " turret (comprised of an Active Gated Television (**AGTV**) and an Inertial Measuring Unit (**IMU**)). In Stage 2/3, the system architecture reached the final configuration described later in this document.

## 1.3 Scope

This document reports on the software integration and test effort conducted by CMC . This report has been prepared in accordance with the ELVISS Airborne HFE Prototype Workstation Contract Data Requirements List (**CDRL**) and associated Data Item Descriptions (**DID**). Specifically, the reports addresses CDRL 006/DID 006 - the Software Integration and Test Report.

In addition, this report provides important information on installation of the software and operation of the ELVISS Airborne HFE Prototype Workstation, also referred to more simply within the document as the "ELVISS Prototype Workstation".

## 1.4 Report Outline

Section One explains the project background and scope. It also provides an overview of the software development process.

Section Two describes the ELVISS Prototype Workstation system, its design and components. Several pictures and diagrams are included to clarify the workstation set-up and operation. System limitations are documented relative to the intended level of capability. System limitations also includes constraints on viewing angles and other aspects of sensor use.

Section Three documents the essential steps required to install the ELVISS Prototype Workstation software.

Section Four explains how to operate the ELVISS Prototype Workstation although it is not a detailed operator's manual. Basic operating instructions are included along with references to other documents. Advice on how to run the simulation of aircraft data is included, along with a detailed troubleshooting guide.

Section Five documents the integration and testing activities undertaken with this project. It is broken down by development stages.

Section Six reports the integration and evaluation results, again by development stages. The results of both Ground and Flight Trials are also reported.

Section Seven presents the conclusions and recommendations arising from the project.

Section Eight lists technical and other document references.

Section Nine identifies acronyms and other short forms used within the document.

# 2 SYSTEM OVERVIEW

## 2.1 General

The conceptual workstation design for ELVISS was developed under a separate contract [Ref. 0] as the culmination of a comprehensive HFE analysis, design, prototype and evaluation. This process, along with the analysis results and the design description, is documented in the ELVISS Human Engineering Design Approach Document - Operator (**HEDAD – O**)[Ref. 0]. Additional preparation for this project was conducted to define the system interfaces with which the ELVISS Prototype Workstation would have to work [Ref 0].

## 2.2 Conceptual Workstation Design

The ELVISS Prototype Workstation design includes five operation states, as shown in Figure 2-1. However, the Diagnostic State and the ability to Re-Initialize are currently out of scope. Grey text and dotted lines are used to indicate the states and transitions which are not available.

The final ELVISS Systems Interfaces Diagram is provided as Figure 2-2. Connection port numbers for the Rocketport serial interface card are shown both here and in the ELVISS Computer Architecture and Interfaces Diagram at Figure 2-3. With respect to video connections, the two sensor video inputs are both RS170, and after passing through their respective DVCAM Recorders, are connected to the applicable video card's red BNC cable.

The NTSC video output from the Orion card is available in both BNC and Y-C formats. For the Ground and Flight Trials, the Y-C format was used as follows:

VID_IN5 (Pin 11, Encoded Video Output, C) connects to C (Chroma) input of DVCAM3.

VID_IN6 (Pin 41, Encoded Video Output, Y) connects to Y (Luminance) input of DVCAM3

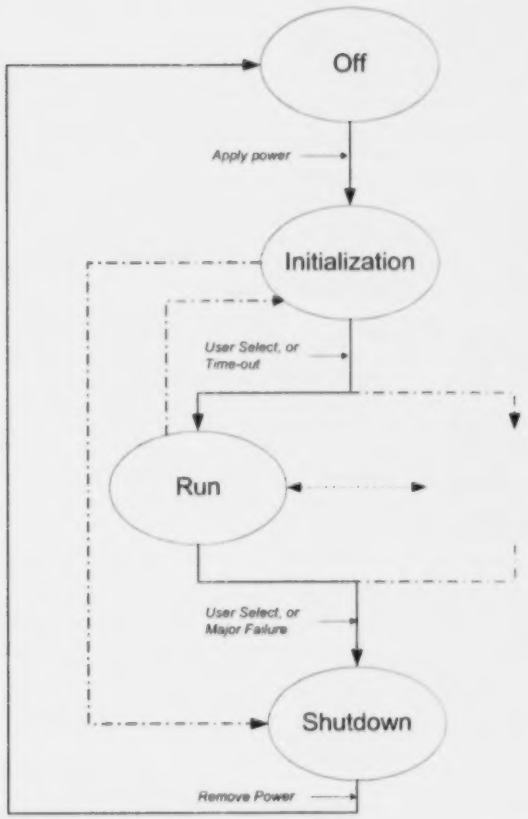


**Figure 2-1 ELVISS State Transition Diagram**

Figure 2-2 FLVISS System Interfaces

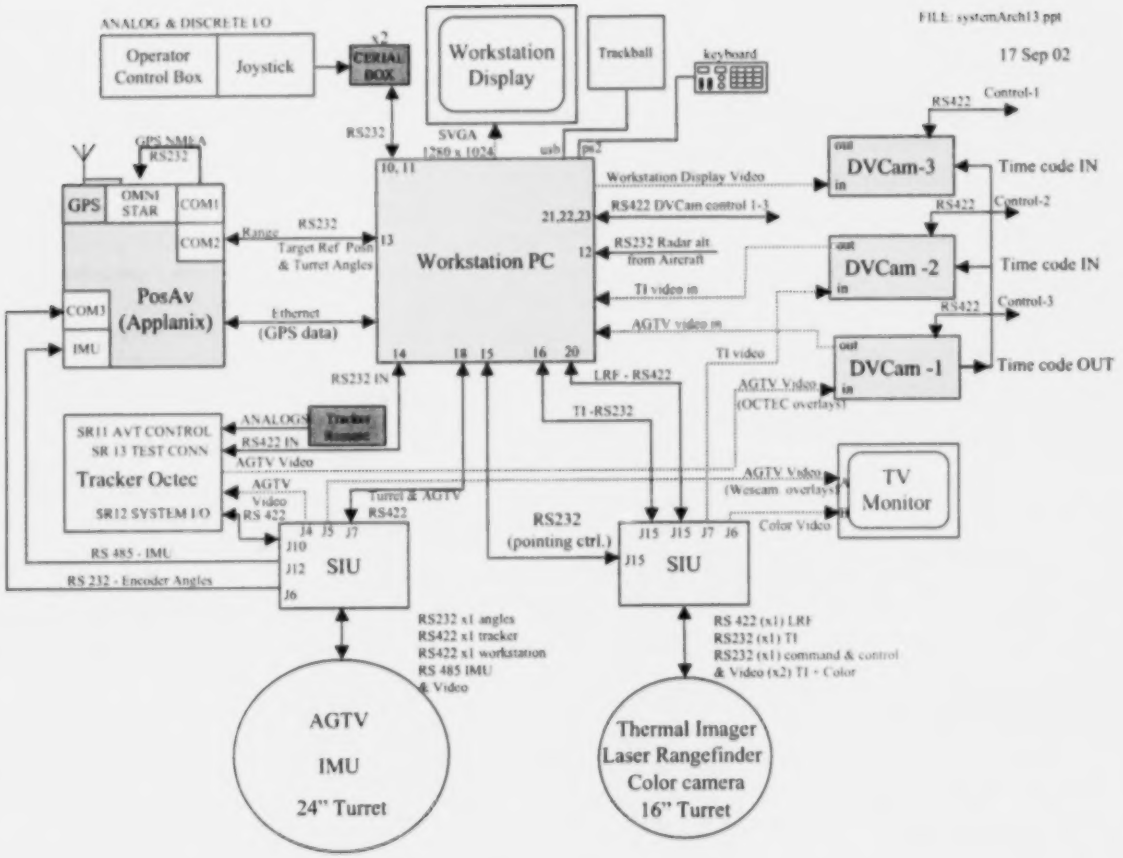


**Figure 2-2 ELVISS System Interfaces**

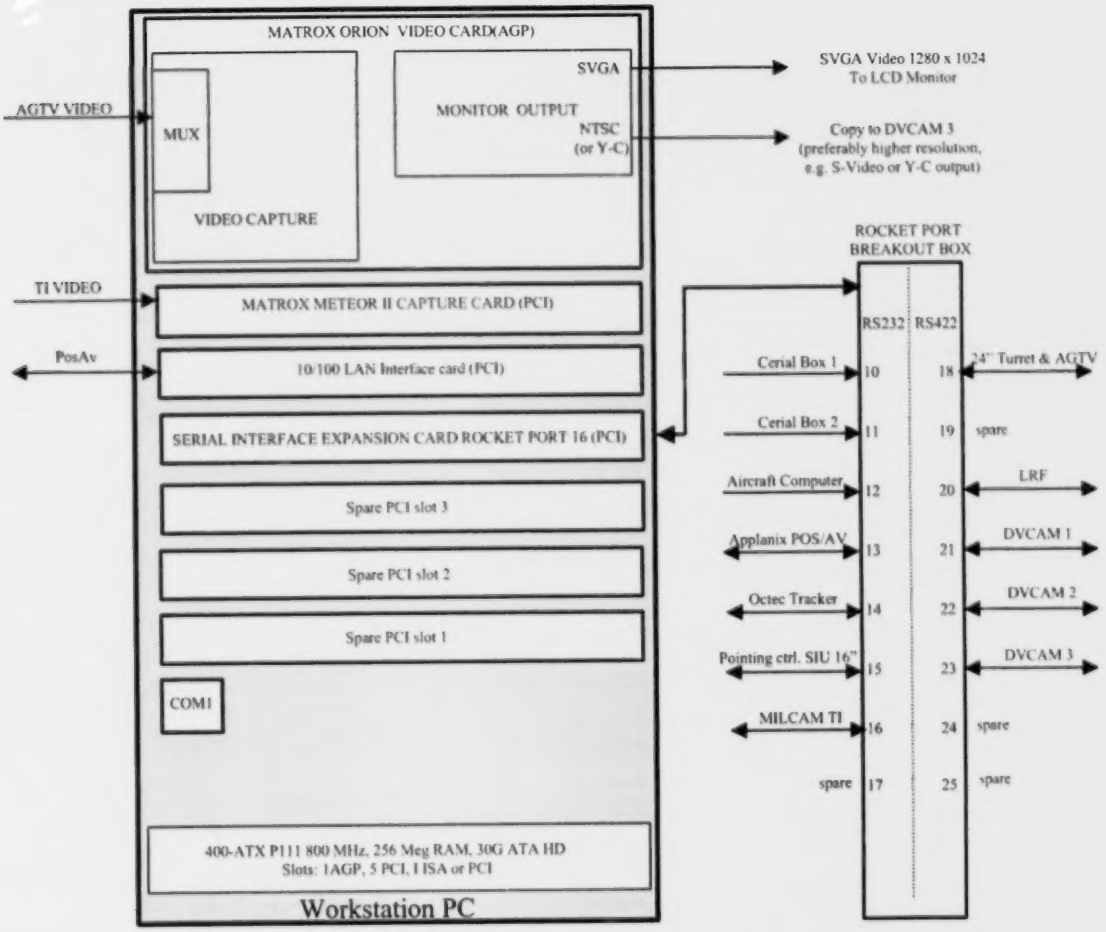


**Figure 2-3 ELVISS Prototype Workstation Computer Architecture and Interfaces**

## 2.3 Components

### 2.3.1 Hardware

The ELVISS Prototype Workstation physical set-up is depicted in the following series of figures:

**Figure 2-4 ELVISS Prototype Workstation Console and Racks**

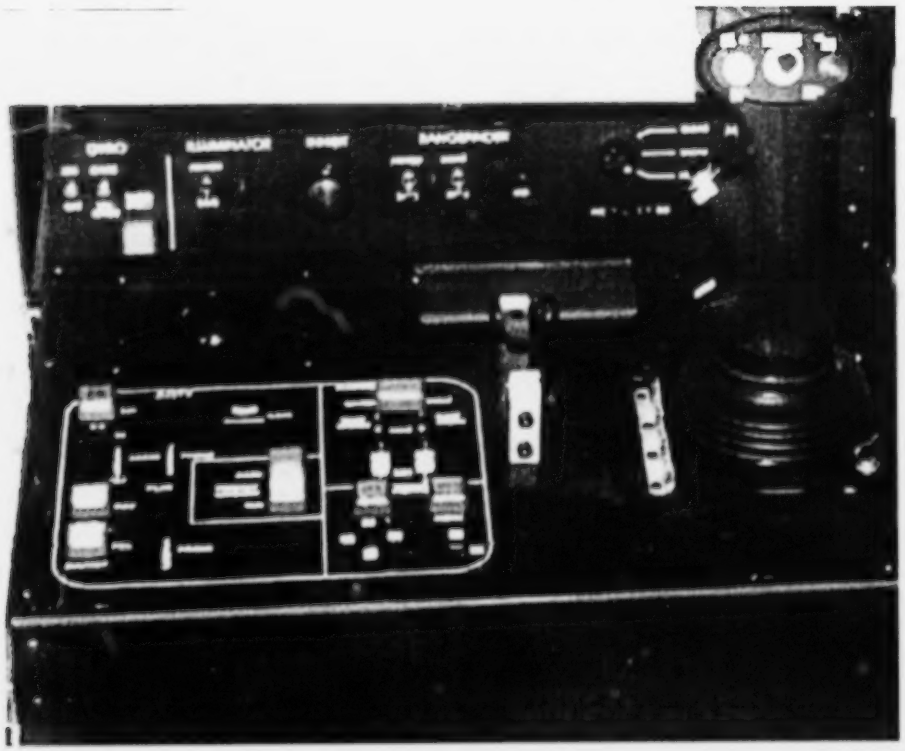

**Figure 2-5 ELVISS Prototype Workstation Control Panel**

**Figure 2-6 ELVISS Prototype Workstation Graphical User Interface**

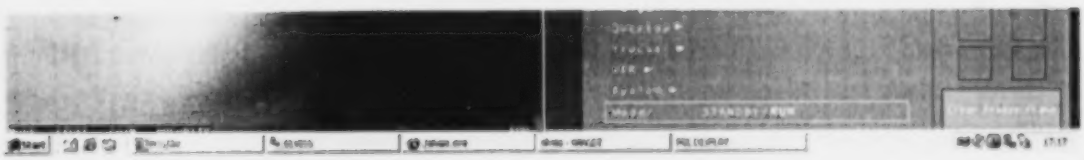

**Figure 2-7 Clipped Screen Shot - Windows Task Bar Visible**

**Note**: In Figure 2-7, the Windows Task Bar is visible, and is hiding part of the TI status overlay. This is the problem identified as Item 12 in Annex H, Flight Trial Evaluation Results for the ELVISS Airborne HFE Prototype Workstation. The problem was resolved by turning off the Auto-Hide feature of the Task Bar.

### 2.3.2 Software

The ELVISS Prototype Workstation prototype is comprised of the following software components. These must be present in order to start up and run the application (See Table 2-1).

**Table 2-1 ELVISS Prototype Workstation Components**

| File Name | Location | Functionality | Comments |
|---|---|---|---|
| sysmag.exe | C:\Elviss_Local_Workspace\ Development\Source\C Files \sysmag\Debug\ | Starts and runs the entire ELVISS application. | A shortcut, named ELVISS, is on the desktop. |
| Elviss_Video.exe | C:\Elviss_Local_Workspace\ Development\Source\C Files \sysmag\Debug\ | Provides the sensor-side of GUI. | Automatically started by: sysmag.exe |
| elviss.exe | C:\Elviss_Local_Workspace\ Development\Source\C Files \sysmag\Debug\ | Provides the Moving Map/Menu side of the GUI. | Automatically started by: sysmag.exe |
| elviss.cfg | C:\Elviss_Local_Workspace\ Development\Source\C Files \sysmag\Debug\ | Stores initial values for operating parameters. | A simple text file read during initialization by sysmag.exe. |
| offsetfile.txt | C:\Elviss_Local_Workspace\ Development\Source\C Files \sysmag\Debug\ | Keeps the previous Boresight offsets for 16 " turret and LRF. | When the application is shutdown, boresight offsets are saved into this file. They will be read during initialization of next run. |
| map_250.bmp | C:\Elviss_Local_Workspace\ Development\Maps | 1:250,000 map. | |
| map_50_1o.bmp<br>map_50_2o.bmp<br>map_50_3o.bmp<br>map_50_4o.bmp<br>map_50_5o.bmp<br>map_50_6o.bmp | C:\Elviss_Local_Workspace\ Development\Maps | 1:50,000 maps. | The 1:50K map is divided into six small maps since a single map for the whole area occupies too much run-time memory. |

The following files, listed in Table 2-2, may be created, modified or used while running ELVISS Prototype Workstation application.

**Table 2-2 ELVISS Associated Files**

| File Name | Location | Functionality | Comments |
|---|---|---|---|
| FreezeFrame1.bmp<br>FreezeFrame2.bmp<br>FreezeFrame3.bmp<br>FreezeFrame4.bmp<br>FreezeFrame5.bmp<br>FreezeFrame6.bmp | C:\ Elviss_Local_Workspace\ FreezeFrame\ | Freeze Frame Images. | Captured and saved at run time by: ELVISS_video.exe. |
| Aircraft_data.exe | Athos: D:\MKS_ADM\Development\ Source\C Files\ Aircraft_data\Debug\ | Can be used to provide simulated Aircraft data for laboratory testing. | Runs on any Windows NT/2000 platform with a serial port (uses Com1). |

## 2.4 Limitations

### 2.4.1 Map Coverage

A map at the 1:250K scale was generated to cover a rectangular region which is 1° by 1° square and which includes the Ottawa area (45 Degrees ° North (**N**) to 46° N and 76° West (**W**) to 75° W). In addition, a subset of this region was provided using six overlapping map files that cover the area from the Ottawa Airport to Connaught Range and into the Gatineau Hills of Quebec (45.26° N to 45.48° N and 75.935° W to 75.465° W). For other areas, a message "Map 50K is not available in this area" is printed out in the ELVISS command window when the 1:50K scale is selected, but the displayed map remains at 1:250K scale.

Although the map database for the Valcartier area was also requested from DND Joint (J)2 Geomatics and Imagery Operations Aerospace, it was not available before the end of the flight trials.

**NOTE**: If the ELVISS Prototype Workstation is operated at a location not covered by the above maps (as determined by the Applanix POS/AV system), then the map overlays will appear over a black background. This means that a map was not generated which covers the current location. This will occur if the ELVISS Prototype Workstation is operated outside the Ottawa area described above. It will also occur if the POS/AV cannot determine an accurate navigation solution (as happened several times when operated in the Bell 412 helicopter while inside the Flight Research Laboratory (**FRL**) hangar).

### 2.4.2 Autoslew Function

The initial implementation of the Autoslew function, was inaccurate because the requested pan and tilt angles are used in the turret to drive the encoder angles. Because of offsets and the influence of the roll encoder angle, the turret could not slave to the desired pointing angles. For the Stow function this was not critical. However, for the Autoslew function the

control loop would run indefinitely because the turret could not be directed to the correct angles. An alternative was implemented which did not require the 24 "turret Slave feature. Instead, the ELVISS Airborne HFE Prototype Workstation now sends joystick commands to turn the turret until the feedback angle from the turret are within 0.5 degrees of the desired angle. Because the control laws used by the workstation are not optimal, the time taken to reach the AutoSlew position is longer than what would be expected if the built-in slaving function could be used. For future implementations, it would be desirable to modify the WESCAM turret software to enable the original slaving option for Autoslew.

### 2.4.3 Position Autotracking

The Position mode of the Autotrack Menu was also implemented at first using the turret slave feature. As for Autoslew, the slaved position had an offset error and was not accurate. This was not as critical as for Autoslew because the user can regain control by turning off the Autotracker (toggling the Autotrack switch on the Joystick). However, the new method for improving Autoslew accuracy was also adopted for Position Autotracking with the same success.

### 2.4.4 Default Autoslew

The default Autoslew function described in the HEDAD-O, to point the turrets to the nose of the aircraft, was not implemented. However during Initialization, the 24" turret is pointed to the nose (pan zero/ tilt zero) to facilitate alignment of the POS/AV navigation subsystem.

### 2.4.5 Cage Switch

While the ELVISS Prototype Workstation is in the Run State, the Cage switch for the 24 " turret only works when the Gyro is 'off'. This is based on the advice that Caging is taken care of automatically by the 24 " turret when the Gyro is 'on,' and the Cage switch is only used for maintenance purposes while the Gyro is 'off'.

### 2.4.6 Re-Initialization

Re-initialization (RE INIT in the System Menu) is not currently available. The functionality was partially implemented but not properly tested.

### 2.4.7 Gate Range and Gate Width Switches

The original design, as per the HEDAD-O, specified slider switches to control the Gate Range and Gate Width parameters of the AGTV. This switch type is quick, effective and provides physical feedback for these analog parameters. Unfortunately, the system response time was very slow because of a mismatch between the hardware switches and the command type available over the AGTV's serial interface. The serial interface is based on the original ALBEDOS console and does not accept direct commands, or absolute values. Instead it uses increment/decrement commands to match the original rocker switches. Although the prototype workstation attempted to marry the two conflicting control protocols, there was an excessive delay between when the sliders were moved until the new value was reached. This caused confusion for the operators during the Ground Trials and made Gate Range and Gate Width adjustments difficult and slow.

For the flight trials, the slider switches were replaced with rocker switches to improve the response times. This change was tested satisfactorily during the Flight Trials. However, for future implementations it would be preferable to modify the AGTV serial interface to accept direct input values (rather than the increment/decrement commands currently used).

### 2.4.8 Multiple Windows

Difficulties were encountered with the integration of the real-time video with the Virtual Applications Builder (**VAPS**) application. The alternate design used requires two application windows: one on the left side for the video and one on the right for the moving map, menu and freeze frames. Although these windows are sized and positioned to look like a single window, it is possible for a user to alter the desired set-up. For example, double clicking on the video window will cause window borders to appear with window controls (double clicking on the window title bar will restore the window to its previous format). Also the window could be moved inadvertently and temporarily upset the layout. This is unlikely for a test subject using a trackball, especially when they are only intended to use the trackball with the moving map. However, experimenters should be aware of this possibility.

### 2.4.9 Standby Mode

Many subsystem functions are not available while the ELVISS Prototype Workstation is in Standby Mode. This is intentional as the turrets are stowed, and the Standby Mode is intended primarily for take-off and landing phases. As soon as the Run mode is entered, the subsystem functions are all available again. In fact if a switch is moved on the Operator Control Panel while in Standby Mode, the ELVISS Prototype Workstation software will detect this upon entering Run Mode and send the appropriate command to the applicable subsystem at that time.

### 2.4.10 Inhibit Button

The Inhibit was intended to provide a physical safety feature equivalent to closing a door over the turret window to prevent radiation from all emitters simultaneously. As this capability was not implemented in the two turret ELVISS, the Inhibit button is instead hard-wired in series with the Illuminator Armed Switch. Either one can break the electric circuit which powers the AGTV Illuminator Laser. It is only wired into the 24" turret and has no effect on the other emitter which is eye-safe.

Although the 24" turret does have an Inhibit function which causes the AGTV sensor package to rotate quickly within the turret housing such that it is no longer looking out the window, this is not being used. The switch value is not currently available to the ELVISS Prototype Workstation software to initiate the necessary turret command. Also, this safety response is slower and less reliable than the current implementation of simply breaking the power circuit to the laser.

### 2.4.11 Heading Accuracy

In the current system, aircraft heading information is received from the POS/AV unit based on Global Positioning System (**GPS**) data. In fact, the heading is estimated based on the motion of the platform referenced to the GPS antenna. The accuracy of this heading information is highly dependent on motion of the GPS antenna because the heading is calculated by plotting a

course through the most recent aircraft positions. This works well for fast jets, but if the platform is stationary or moving slowly, the estimated heading will often be wrong and the error can be very high.

This heading inaccuracy was seen in the laboratory environment (which was stationary), the ground trials (very slow movement) and even occasionally in the flight trials. The flight trials included a lot of hovering and low speed manoeuvres. While in hover, the change in aircraft position is useless for calculating heading. Often the small helicopter movements required to hover will be within the resolution of the GPS position accuracy, and these two factors will contribute randomly to a heading calculation which is totally meaningless.

Unfortunately large heading errors will greatly affect operator use of the map and camera footprint overlay. The aircraft icon rotates according to the heading data being received, while the footprint is drawn at the correct viewing angle. Interpretation of aircraft motion will be erroneous and confusion is likely when the operator compares the polar plot with the aircraft icon/camera footprint on the map. The angle of the camera relative to the nose of the aircraft should be the same in both cases, but any errors in aircraft heading will prevent this.
It is recommended that a new, more accurate source of aircraft heading be identified and used by the ELVISS Prototype Workstation. If further trials are conducted on FRL's Bell 412, it is understood that there are two possible sources of accurate heading, both available from the aircraft computer: magnetic compass heading and a filtered compass/Inertial Navigation System (**INS**) heading.

### 2.4.12 Radar Altitude

The Bell 412 Radar Altimeter is not accurate at heights greater than about 1500 feet above ground level (**AGL**). Therefore, the ELVISS Prototype Workstation reverts to GPS altitude when the Radar Altimeter data input exceeds 1500 feet AGL. The map overlay indicates the difference using **AGL** for radar altitude and Above Sea Level (**ASL**) for GPS Altitude (which is height above mean sea level). Also, if the radar altitude input is negative, the ELVISS Prototype Workstation will display this as zero, meaning that you are either on the ground or very close to it.

### 2.4.13 Ergonomics

Although some efforts were made to optimize the ergonomics of the ELVISS Prototype Workstation for the flight trials, there were several limitations which impacted on the comfort and performance of the operators. On the positive side, the orientation of the workstation was excellent because the operators were facing forward - the same as the pilots and in the same direction as the reference position of the sensors, i.e. looking towards the nose of the aircraft. Therefore, the pilot's 10 o'clock direction matched the 10 o'clock direction of the operator, as well as aligning perfectly with the polar plot indicator on the workstation. The polar plot's reference direction is the nose of the aircraft, and the aircraft icon lined up perfectly with the real aircraft because of the orientation of the workstation.

In general, however, the ergonomics of this temporary set-up was poor. Specific problems included:

- seat height was too low relative to the control panel, as well as to the monitor, affecting comfortable reach and viewing angles;
- the height of the joystick above the control panel, in combination with the low seat height, caused arm fatigue (a foam armrest was added for the last flights);
- the trackball position was awkward to reach and use, especially for right-handers;
- a jump seat (which is not intended for operators) was used for the workstation; and
- a circuit breaker panel protruded behind the operator (in place of a backrest)

### 2.4.14 Polar Plot

Because of integration problems between the VAPS prototyping tool and the real time video application, the left side of the GUI had to be redone as part of the video application. Limitations of that application resulted in a minor reduction in fidelity of the polar lot. The only significant problem was the lack of an arrow head on the pointer.

### 2.4.15 Video Status Overlays

When drawn using VAPS, the textual information in the video status overlays could retain its readability over a changing sensor background using a text outline or halo feature. This is basically the addition of a black outline around the white text. Unfortunately when this side of the GUI had to be redone using the Matrox video application, the ability to outline text was lost. The alternative was to put a black background behind all text fields. This slightly reduced the viewable sensor areas, but was considered acceptable for the Ground and Flight Trials.

### 2.4.16 Sensor Boresighting

The two turrets were physically mounted so that they would have the same zero/zero reference orientation for pan and tilt angles. For minor differences in boresight angles between the AGTV and TI cameras, it is possible to modify one or both of the internal turret offsets to their pan and tilt angle values. However the ELVISS Prototype Workstation has a System sub-menu specifically developed for aligning the 16" turret with the 24" turret while viewing the camera images within the ELVISS Prototype Workstation GUI. Because there is a lateral separation of several feet between the two turrets, this software alignment feature is good for a limited range of viewing angles and depth of field. See Figure 2-7 for an exaggerated graphical representation of the pan angle errors related to trying to align images generated from two physically separated turrets. Similar effects occur for the tilt dimension, and errors may vary with the viewing angle. For example, in Figure 2-7A the 24" Turret is looking broadside from the helicopter (90°) which is the best viewing direction for turrets mounted on the port side of the aircraft. As the 24" Turret is steered left or right of the 90° (where the software boresight alignment is usually done), the errors will vary as the 16" turret is slaved to follow at the fixed offset angles.

It should also be noted that even for the "Target Aligned" region shown in Figure 2-7B where the centre of the target image will be aligned, there will be a perspective error between the two images because of the different slant angles. Both boresight and perspective errors will

decrease with viewing distance. For example, at a 1000 meter range and assuming a physical displacement between the turrets of 2 meters, the center of the two turret images would be offset by only about 7 arc minutes (arcsin [2/1000]). Changing the boresight offset of the second turret by 7 arcmin to align the two images would not create a noticeable perspective error. Similarly, at a range of 500 meters, the offset would need to be 14 arcmin.

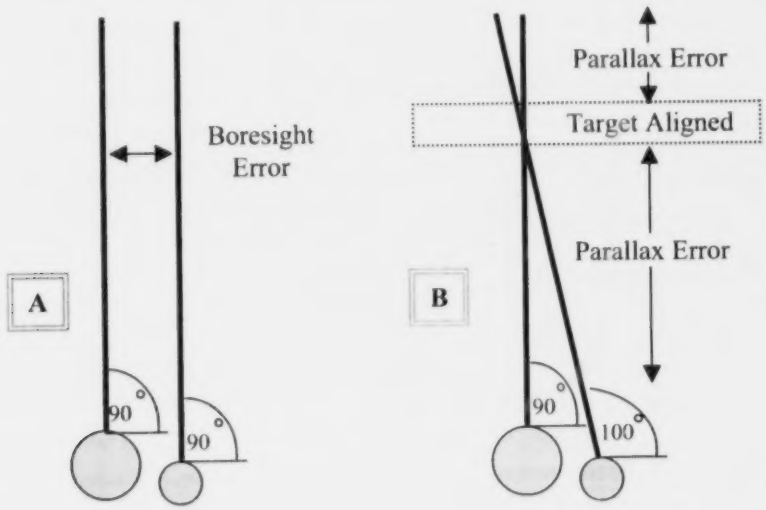


**Figure 2-8A Pan Angle Boresight Error after Physical Turret Alignment**
**Figure 2-8B Pan Angle Alignment Errors after Software Boresight Alignment**

Two System Menus are provided for sensor boresighting. Usually the operator would first boresight the 16" Turret to the 24" Turret using the 16" Turret Boresighting Menu and the two camera images (AGTV and TI). When the last step of the menu is reached, the final offset angles are applied to all further pan and tilt command angles sent to the 16" Turret while in Slave Mode. However, they are only optimized for the target range and viewing angles used during the boresighting operation.

The LRF Menu is used to align the LRF with the TI image. This alignment is for the LRF boresight relative to the TI camera boresight, both of which are in the 16" turret. During this alignment, the crosshair on the TI image is shifted until it lines up with the target which is providing the correct range returns. This feature was not tested enough to identify any limitations.

Unfortunately, during most of the flight trial, the AGTV and thermal imaging sensors were not aligned, causing severe direct and indirect problems. The operator was relying a lot on the thermal image for situation awareness and to detect potential targets and on the AGTV to confirm and identify these targets. However, the misalignment was such that it was almost impossible to use the two imagers at the same time. The operator had to select which sensor he wanted to use depending on the scenario. Another consequence to this misalignment was that,

because the laser rangefinder was in the 16-inch gimbal and not in the 24-inch turret with the AGTV/IMU, the error on target position when designating a target was inaccurate. Also, an indirect problem related to the misalignment was caused by the hovering of the helicopter which did not allow the POSAV to accurately determine the flight direction of the helicopter and consequently its bearing. Hovering was required to allow enough time to the operator to find and identify targets (see also 2.4.11.)

The continuous misalignment between the two imagers was mainly caused by the fact that they were installed in two airborne platforms (AGTV in the 24-inch turret and the thermal imager in the 16-inch one) of different mechanisms for the stabilization. The 24-inch gimbal uses a pendulum principle (the sensor is on a floating table always horizontal) and the 16-inch is strictly a gimbal. So when the aircraft was rolling, yawing or pitching, the 24-inch was keeping its floating table (and the AGTV/IMU) perfectly horizontal, such that the IMU was not sensing any angular acceleration (or very little). As for the 16-inch gimbal, the pointing direction and consequently the FOV of the thermal camera followed the angular change of the aircraft. This is because the 16-inch gimbal never received commands from the IMU (being stable in the 24-inch) to correct its pointing direction. To solve this particular problem requires the inputs of the gyros from either the 24-inch turret or from the aircraft. This will be subject to an enhancement phase later.

### 2.4.17 Camera Footprint

The camera footprint is not adjusted with respect to camera Field of View (**FOV**) or pan, tilt and range values. Instead a fixed size footprint icon has been used to represent the camera footprint. Implementation of this feature was not within the project budget.

At shallow viewing angles, the range calculation is no longer valid (as indicated in the Range display field). In this case, even the position of the footprint is uncertain so the footprint icon is hidden and the camera pointing vector is simply extended to the edge of the map to indicate this condition.

### 2.4.18 History Overlays

The inclusion of aircraft track history and camera search history overlays was not feasible within the scope of this project. Although versions were developed for the original laboratory prototype to support user interface evaluations, an additional effort would be required to redo this feature with the accuracy required for flight trials.

### 2.4.19 Status Page

The Status Page button on the Operator Control Panel is not functional. All maintenance and diagnostic functionality was outside the scope of this project.

### 2.4.20 NTSC Colour Recording

During Flight Testing, a problem was identified with the colour formatting of the ELVISS Prototype Workstation 's NTSC output. In fact, the NTSC video output (representing the workstation Window's desktop) appeared as a monochrome image on the TV Monitor.

However, the colour was restored when the RS170 AGTV signal was passed through a DVCAM Recorder before being input to the Orion graphics/video card.

This required a procedural workaround because the DVCAM had to be in Record mode (or fake Record mode) before it would pass the AGTV video signal through to its output channel. While the DVCAMs are not in Record mode - as controlled from the ELVISS Prototype Workstation Video Camera Recorder (**VCR**) Menu, the operator has to put DVCAM 1 into Local mode, and press the Record button in order to get AGTV video to appear on the main workstation screen. Before the operator can use the ELVISS Prototype Workstation VCR Menu to start simultaneous recording, they have to first press Stop on DVCAM1, and put it back into Remote control mode. The AGTV video will be temporarily lost during this transition.

### 2.4.21 Pan and Tilt Limitations

Although both turrets can be steered through a full 360° in pan and close to ±90° in tilt, there are some large blind spots. Due to the mounting locations of the two turrets, any pan angles greater than approximately 180° in combination with positive tilt angles will result in some obstruction of the visual imagery because the helicopter airframe will be blocking the view. For the same reason, neither the LRF, nor the AGTV active imaging mode should be used in this situation.

In the pan angle range of approximately 150-180°, the 24" Turret may obstruct the TI image and LRF operation. This will occur for tilt angles near the horizontal, e.g. -20° and above. Similarly, the 16" turret may block the AGTV image for pan angles of 0-30°, again for tilt angles near the horizontal.

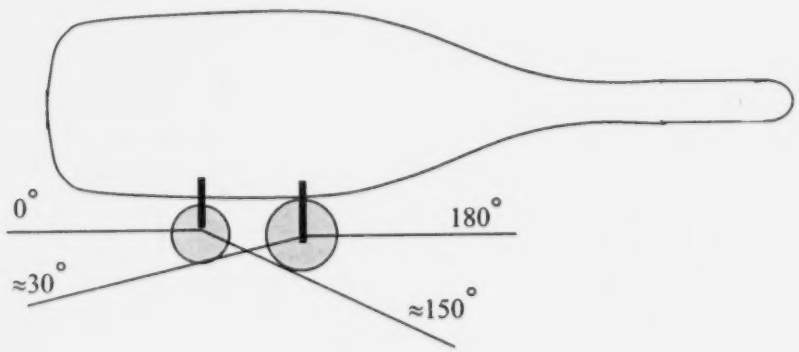


**Figure 2-9 Pan Angle Limitations for Near Horizontal Tilt Angles**

### 2.4.22 Sensor Operating Ranges

The AGTV camera is designed to operate at ranges between 30 metres and 10 kilometres.

The LRF is capable of providing target ranges at distances between 50 metres and 20 kilometres.

**CAUTION**: The ELVISS Workstation Personal Computer (**PC**) should be started up before the 16 " turret is turned on. This is because the 16 " turret produces noise (i.e. Electro-Magnetic Interference (**EMI**)) that is picked up by the workstation through the Rocket Port and interpreted as a serial mouse input. This noise makes the mouse go crazy. This can be avoided by following the start up procedures.

# 3 INSTALLATION

For successful operation, the following files must be located in the same directory, specifically, C:\Elviss_Local_Workspace\Development\C Files\sysmag\Debug:

*sysmag.exe*
*Elviss_video.exe*
*elviss.exe*
*elviss.cfg*
*offsetfile.txt*

Because their paths are hard-coded in the VAPS module, the following map files must be located in C:\Elviss_Local_Workspace\Maps:

*map_250.bmp*
*map_50_1o.bmp*
*map_50_2o.bmp*
*map_50_3o.bmp*
*map_50_4o.bmp*
*map_50_5o.bmp*
*map_50_6o.bmp*

**NOTE**: The map files cover a specific geographic area. If the ELVISS Workstation Prototype is operated outside the area currently represented by the map set, no map image will be appear in the moving map window. However, everything else should work as expected. The map files prepared for the flight trials, and which were delivered with the workstation, are for the local Ottawa/Gatineau area. A different geographic area can be represented if a new set of map files is generated with equivalent file sizes and the new coordinates are registered in the prototype software.

The file "offsetfile.txt" is used to save the offset positions of previous boresight operations. If this file is lost, a new one can be created simply using the Windows Notepad application. Enter "0, 0, 0, 0" into the file for initial values, and save the file into the directory named above using the name "offsetfile.txt".

If any of the other files identifed above are lost or corrupted, they can be replaced with copies from the CD-ROM backup provided to DRDC Valcartier.

*It should also be noted that the C:\ Elviss_Local_Workspace\FreezeFrame\ directory must exist to store Freeze Frame images at run-time.*

# 4 OPERATION

## 4.1 Start-up

Follow the "Start-up Procedure for the ELVISS Airborne HFE Prototype Workstation " in Annex A (below).

If one or more subsystems are not available, a message will appear in the command window before the graphical applications are launched. The ELVISS Prototype Workstation application should continue with whatever subsystems are available, but functionality for failed or missing subsystems will be missing.

## 4.2 Switching Between System States and Modes

To change system states, go to the System submenu and use the <+> and <-> rocker switch to request the desired state. Some state changes incorporate a user confirmation box.

To change between Standby and Run Modes while in the Run State, you can either use the top-level Operator Menu, or the System submenu.

## 4.3 User Interface

The HEDAD-O [Ref. 0] explains the functionality of the operator control panel, including the joystick and trackball. A few exceptions are noted Section 2, Limitations - see 2.3.7 and 2.3.10.

The menus were revised during this project to match the current subsystem features. For example, the Thermal Imager Menu in the HEDAD-O was designed for the AGEMA camera, and had to be updated to support the MilCAM XP sensor. The final menus are specified in Annex C ELVISS Airborne HFE Prototype Workstation Menus.

## 4.4 Shutdown Procedure

Follow the "Shutdown Procedure for the ELVISS Airborne HFE Prototype Workstation " in Annex B (below).

## 4.5 Simulated Aircraft Data

For ground testing, a CMC computer - *athos* - was used to generate simulated aircraft altitude data. The file name of the executable is "Aircraft_data.exe". It can be found in the "D:\MKS_ADM\Development\Source\C Files\Aircraft_data\Debug" directory (on *Athos*). Aircraft_data.exe can be started before or after sysmag.exe (i.e. The order of execution does not matter).

This simulation program was also loaded onto the ELVISS Prototype Workstation computer, and can be started from a shortcut icon on the desktop. However, to receive simulated data from the "Aircraft_data.exe" program, the RS232 cable from port 12 on the Rocketport

interface needs to be connected to the Com1 port of the ELVISS Prototype Workstation computer (instead of being connected to the Bell 412 aircraft computer).

### 4.6 System Configuration File

The ELVISS Prototype Workstation program reads the "elviss.cfg" file during Initialization and uses the parameters stored in this file to set start-up values for system and subsystem operation. This file can be opened and edited with any text editor, but should always be saved as a text file. The file format is self-explanatory. In fact, the permissible values for each parameter are included as a comment beside each entry. It must be noted that for text values, the entries must match the stated options exactly.

### 4.7 Troubleshooting

A troubleshooting guide has been prepared and included as Table 4-1.

**Table 4-1 ELVISS Prototype Workstation - Troubleshooting Guide**

| # | System State | Fault | Probable Cause | Remedial Action |
|---|---|---|---|---|
| 1 | Initialization | Cursor is continuously erratic, moving without mouse input. Left and right mouse buttons may also activate spontaneously. | The computer was receiving a live input through one of the serial ports during the last boot-up and the computer has confused this serial port with the mouse input. | 1. Follow the ELVISS Shutdown Procedure, ensuring all subsystems have been powered off.<br>2. Reboot the computer. |
| 2 | Initialization, Standby, Run | Cursor becomes erratic only when a specific subsystem is activated, i.e. moving without mouse input. Left and right mouse buttons may also activate spontaneously. | The computer is occasionally receiving input from an open serial port and the computer is confusing this serial port with the mouse input. | 1. Identify the subsystem causing the interference.<br>2. Follow the ELVISS Shutdown Procedure, ensuring all subsystems have been powered off.<br>3. Use the Port Monitor tool (available from the Windows Start Menu) to Reset the applicable Com Port. |
| 3 | Initialization | There is no map in the Moving Map display area, or the indicated aircraft position is wrong. | If the POS/AV unit is still not fully aligned yet, inaccuracies in the position data may result in an aircraft location which is not covered by the available maps. | 1. No action required. As the POS/AV unit finishes alignment, the map should appear correctly.<br>2. If not, see Item 4. |
| 4 | Standby, Run | There is no map in the Moving Map display area. | The available map image files do not cover the current location of the ELVISS Prototype Workstation. For the initial flight trials, an area of about 25 square miles around the Ottawa Airport was included for the 1:250,000 scale map. A subset of this area for the local Ottawa Airport and Gatineau Hills region was provided for the 1:50,000 map. | 1. If the aircraft (or ELVISS Workstation) is temporarily outside of the intended flight trial area, no action is required. The map will reappear as the aircraft transition into the area covered by the available maps.<br>2. If additional map coverage is needed, new map files need to be generated from the J2 Geomatics Database and added to the ELVISS application. |
| 5 | Standby, Run | The 1:250,000 scale map is displayed when the 1:50,000 map is selected, and an advisory | If a 1:50,000 map is not available for the current location, the wider area 1:250,000 map will be automatically | 1. No action required.<br>2. However, the advisory message in the map overlay can be cleared by |

| # | System State | Fault | Probable Cause | Remedial Action |
|---|---|---|---|---|
| | | appears "1:50 Map not available". | displayed. | switching to the 1:250 setting. |
| 6 | Run | One or both of the turrets drift in pan or tilt when no joystick input is provided. | There may be an incorrect bias being applied to the joystick input, resulting in a zero joystick displacement being interpreted as a non-zero steering command. | 3. Select the Turret Menu.<br>4. If in Slave Mode or 24" Turret Only, select the 24" Turret NullZero function.<br>5. If in 16" Turret Mode Only, select the 16" Turret AutoNull function.<br>6. When the null function is finished running, the drift should be gone.<br>CAUTION: Do not touch the joystick during the NullZero or AutoNull procedures. |
| 7 | Run | One or both of the turrets are not responding consistently to the joystick input, e.g. spinning in one direction independently of the joystick position, or other erratic movement | This is usually the result of a hardware failure such as a grounding problem in the control panel or a wiring problem. | 1. Shutdown the ELVISS Prototype Workstation, following the ELVISS Shutdown Procedure.<br>2. Use a meter to identify wiring/grounding problems. |
| 8 | Run | No AGTV or TI video. There may also be a status message displayed on the screen indicating video problems or a more general sensor failure. | 1. The ELVISS Prototype Workstation may not actually be in the Run State. Live video is only displayed while in Run State.<br>2. One or both of the sensors may not have initialized correctly, or there may have been a failure during runtime.<br>3. One or both of the sensors is not connected to the Workstation correctly. | 1. Use the top-level Operator Menu or the System Menu to verify the system is in the Run State.<br>2. Verify the sensors are powered on and there are not error messages.<br>3. Toggle between Run and Standby States to re-start the video grab functions.<br>4. Check the input cables to ensure the AGTV video input is connected (via the Octec Video Tracker) to the Orion board, and the TI video input is connected to the Meteor II board. |

| # | System State | Fault | Probable Cause | Remedial Action |
|---|---|---|---|---|
| 9 | Run | No TI video. | The thermal camera cooling system may not have reached the correct temperature yet. | 1. If it less than five minutes since the 16" turret was powered up, wait a few more minutes.<br>2. Otherwise, follow Remedial Action for "No AGTV or TI video" (Item 8). |
| 10 | Run | The AGTV and TI images are not aligned. | Because the two sensors are in different turrets, they cannot be boresighted together. For mid to long range viewing, the two images can be aligned using a software alignment process. This may have to be repeated occasionally. | 1. Select the System Menu.<br>2. Select the 16" Boresighting option.<br>3. Follow the directions on the 16" Boresighting Menu.<br>4. The new 16" offset values will be saved for future use after the final step in the process.<br>Note: If you exit prematurely by selecting the <Menu> button before moving to the last step (Step 5), the new values will be available for the rest of the flight, but will be lost when the system is shutdown. |
| 11 | Run, Shutdown | The ELVISS application freezes and a normal shutdown using the System Menu is not possible. | Potential conflict between ELVISS application processes and the Windows Operating System. | 5. Use the keyboard shortcut <Alt><F4> to close the ELVISS application (Note: there are two windows, so both have to be selected and given the <Alt><F4> command).<br>6. Alternatively, use the keyboard shortcut <Alt><Tab> to find the DOS command windows and close them using <Ctrl><C>. Note the last messages printed to the command windows for reference in further diagnosis. |

# 5 INTEGRATION AND TESTING

## 5.1 General

The development and integration of the ELVISS Prototype Workstation software started as a 3 Stage effort organized around the availability of the two turrets and subsystems. As work progressed and availability factors changed, a decision was taken to combine the last two stages into a single development stage. This also served to minimize costs and maximize the final level of functionality. This combination of stages was designated *Stage 2/3* because it included most of the functionality intended for both Stage 2 and 3.

A summary of workstation capabilities developed in each stage is described below. For the detailed breakout of functionality allocated to each stage, see Table 5-1.

## 5.2 Stage 1

In Stage 1, the ELVISS Prototype Workstation was integrated with the 16 " turret, the TI, the LRF, the POS/AV position and orientation unit, and one DVCAM video recorder. Applicable on-screen menus of the GUI were activated, and video images from the Day Camera and TI were grabbed and displayed by the workstation video cards. The Day Camera was a substitute video input for the AGTV video, and was only needed to verify the basic video functionality and identify any performance limitations.

## 5.3 Stage 2/3

For Stage 2/3, the major changes included the integration of the 24" turret and associated mission equipment such as AGTV and the video Auto Tracker. The other two DVCAM video cameras were also integrated during the Ground Testing. The Radar Altitude interface had been identified as an RS232 serial port and the radar altitude data interface was simulated using a software emulator on the development platform *Athos*. During the preparation for Flight Trials, the ELVISS Prototype Workstation was quickly integrated with the Bell 412 aircraft at the Flight Research Laboratory. Also, in this stage, a 1:50K moving map was added so the operator can switch between it and the 1:250K map. Graphical overlays and status overlays were further developed over the sensor image and map areas. Some functionality was descoped from this project to accommodate the impact of equipment availability, hardware repairs and various integration problems. Some specific items which were left out include the aircraft and search history map overlays, as well as a dynamic footprint icon (currently a fixed size icon).

The Integration Test Plan generated for Stage 2/3 final integration, also prepared the ELVISS Prototype Workstation for the customer evaluations which took place in two phases: Ground Trials and Flight Trials. See Annex D for an outline of the Stage 2/3 Integration Test Plan, and Annex E for a description of the test plan used to verify changes arising from the Ground Trial test activities. After completion of the integration testing and resolution of software deficiencies, the ELVISS Prototype Workstation was made available to DND for the Ground and Flight Trials.

**Table 5-1 Stage Definition Document - Final**

| Component | Stage 1 | Stages 2 and 3 (combined) | |
|---|---|---|---|
| A. Display Formats | 1. All screen display formats transferred to PC<br>2. Update menus:<br>a. modify Turret menu as needed for second turret controls;<br>b. remove items not needed for initial trials;<br>c. remove colour/brightness controls for overlays;<br>d. revise autotracker and IR menus to reflect final functionality;<br>e. revise State/Mode controls as needed. | - none - | - none - |
| B. System Software | 1. Create three system states: Initialization, Run and Shutdown<br>*Initialization*:<br>2. Use text file to load variable start-up parameters<br>3. Open communication links, start-up and configure subsystems<br>4. Configure workstation & transition to Run state.<br>*Run*:<br>5. Manage system and subsystem functionality, as specified<br>6. Provide shutdown function from Operator menu<br>*Shutdown*:<br>7. Shutdown connected subsystems & | 9. Create a "No TI" mode for the Run state (no RS232 connection, just emulated video available)<br>10. Create a "Standby" mode for *Run* state (for use during take-off and laboratory development)<br>11. Add new subsystems (start-up, shutdown, etc)<br>12. Verify critical switch settings before permitting Initialization of turrets, e.g. Illuminator "Safe" | - none - |

| Component | Stage 1 | Stages 2 and 3 (combined) | |
|---|---|---|---|
| | close communication links<br>8. Exit software programs | | |
| C. 24" Turret | - not available - | 1. Integrate RS422 interface<br>2. Provide turret menu controls<br>3. Provide steering commands according to joystick input | - none - |
| D. Active Gated TV (AGTV) | 1. Emulate video input for test purposes (use Day camera video) - AGTV not available | 2. Integrate RS422 interface<br>3. Replace emulation video with AGTV video<br>4. Provide passive operation controls via Sensor Control Panel and menus | 5. Add active operation controls |
| E. Autotracker | -none - | 1. Provide On/Off control from Joystick<br>2. Provide menu controls for Auto/Man, Position/Target, Window Size, and Position Detect setting.<br>3. Connect Remote Control Unit to provide Threshold & Polarity control | 4. Add remaining menu controls |
| F. Position & Orientation System (POS/AV) | 1. Integrate RS232 interfaces<br>2. Provide range data from laser rangefinder to POS/AV<br>3. Receive GPS data & Target Reference Position from POS/AV | - none - | - none - |
| G. 16" Turret | 1. Integrate RS232 interface<br>2. Provide turret menu controls<br>3. Provide steering commands | - none - | 4. Provide steering commands to slave this turret to the 24" turret<br>5. Add software boresighting function |
| H. Thermal Imager (TI) | 1. Integrate RS232 interface | 4. Emulate video input for test purposes (use Day camera video) | 6. Replace emulation video with AGTV video |

| Component | Stage 1 | Stages 2 and 3 (combined) | |
|---|---|---|---|
| Imager (TI) | 2. Add basic control functions (Sensor Control panel and basic menu controls including Level, Gain and Reticle On/Off)<br>3. Display video | (use Day camera video)<br>5. Operate in "No TI" mode | video<br>7. Add other menu control functions as required |
| I. Laser Range Finder | 1. Integrate RS422 interface<br>2. Provide menu and Bezel Control Panel functions<br>3. Drive Range output display on screen | 4. Modify Continuous Mode laser firing timing | 5. Add software boresighting function |
| J. Colour/Day Camera | 1. None | - not available - | - not used - |
| K. DVCam Recorders | 1. Integrate RS-422 interface for automatic Initialization and Shutdown functions<br>2. Connect DVCam recorders to available video signals | 3. Provide Stop and Record control from the workstation - use simultaneous signal to all three recorders | 4. Set time on DVCAM1 during Initialization and reset prior to each Record request. |
| L. System Functionality (*Run* State) | 1. Integrate Joystick and provide Target Designate function with Freeze Frames<br>2. Provide simple map implementation (North Up, one scale- 1:250000)<br>3. Provide Operator and Overlay menu controls<br>4. Correlate freeze frames with map icons | 5. Drive Polar Plot and Tilt Angle display outputs<br>6. Provide target Bearing display | 7. Add camera footprint (time/resources permitting), sensor search history (time/resources permitting) and aircraft track history (time/resources permitting) on the moving map with Clear, Show, Hide functions<br>8. Integrate Trackball and add Position Designate function<br>9. Add AutoSlew function<br>10. Simulate Radar Altimeter input from aircraft (New entry). |

# 6 INTEGRATION AND EVALUATION RESULTS

## 6.1 Stage 1

The results of the customer evaluation which took place at the end of Stage 1 are presented in Annex F.

## 6.2 Stage 2/3

The results of the Ground and Flight Trials are documented in Annexes G and H, respectively.

## 6.3 Summary

Of the thirty deficiencies and improvements identified during the Stage 1 Evaluation, twenty-eight resulted in changes to the software and/or the system set-up. The major concern at this point was with respect to performance and particularly the update rate of the video (Annex F: Items #6, #10 and #11). Priorities were set and modifications made accordingly to ensure satisfactory performance for the Flight Trials.

Other significant concerns were related to ensuring a safe start-up sequence (Annex F: Items #1 and #2), LRF settings (Annex F: Items #13-16) especially for the Continuous Mode, and some POS/AV data interface problems (Annex F: Items #17-18). As per the Annex F results, all Medium to High priorities items were addressed satisfactorily.

Forty-three items were recorded from the Ground Test Evaluation. This was the first opportunity to test the system in realistic environment so many of the changes made were to optimize control and display functionality. For example, the TI focus switch was too sensitive (Annex G: Item #4) when used at normal viewing ranges (rather than short range in the lab). Similarly, the response time for changing AGTV Gate Range and Gate Width settings was slow in the lab, but unacceptable in the field (Annex F: Item #15). Of the 43 items, thirty-six were addressed by CMC before the Flight Trials. The other seven were either deferred or identified as issues for other vendors.

It was also during the Ground Test Evaluation that large heading inaccuracies were identified as a major problem (Annex G: Item #30). It was expected that heading accuracy would improve significantly during the Flight Trials because the POS/AV heading calculation requires continuous movement at aircraft speeds. However, the heading accuracy did not improve enough (Annex H: Item #3) because of the considerable amount of time that the helicopter was hovering or moving slowly during the Flight Trials.

The results observed by CMC during the Flight Trials are reported in Annex H. However CMC was not involved in all Flight Trial tests. This summary of evaluation results in not necessarily all-inclusive, rather it includes items which were reported to CMC by DRDC evaluators or noticed by CMC directly.

# 7 CONCLUSIONS AND RECOMMENDATIONS

## 7.1 Conclusions

It is concluded that:

a) Conversion of the ELVISS laboratory prototype, to a flying prototype which interfaced with ten mission and aircraft subsystems, was a complex activity which required an extended development period of ten months. Numerous integration problems were encountered and resolved - some with workarounds, rather than optimum solutions.

b) The full functionality envisioned for the production system could not be provided within the budgetary constraints of this project. However, the essential requirements were identified and prioritized using the Stage Definition Document [Ref 0], and the necessary capability was developed to support the DND Flight Trials. The majority of the remaining features, especially those affecting the operator interface, are independent of the transition from two turrets to one, and could therefore be done immediately.

c) The most significant integration issue was the requirement to slave the 16" turret to the direction of the 24" turret. The method employed worked fairly well in the laboratory and during ground testing, but during the Flight Trials the added dynamics of the aircraft movement significantly degraded the ability to keep the 16" turret aligned with the 24" turret. As a result, the TI image was never fully aligned with the AGTV image. This was particularly noticeable while in Wide FOV. A reduction in the pan and tilt gain of the 16" turret helped by preventing overshoot in the control loop. The final solution of this problem is the integration of all sensors into a single turret. To solve this particular problem while still using two turrets would require the inputs of the gyros from either the 24-inch turret or from the aircraft and the calculation of countering offset commands to the 16-inch turret.

d) Heading accuracy was variable, but usually poor. The current source, POS/AV using the GPS input of estimated heading based on the last few position fixes, is only accurate when the platform is moving quickly. This caused a problem with the aircraft icon as well as the camera footprint overlay on the moving map. In the hover particularly, the heading indicated by the aircraft icon and relative position of the camera footprint (which was accurate) did not correlate with the Polar Plot.

## 7.2 Recommendations

It is recommended that:

a) In the event that time and resources permit, the flying prototype be extended to include some or all of the remaining features needed to complete the full workstation functionality, as defined in the Stage Definition Document [Ref 0]. Operator interface features such as an accurate camera footprint, search history, aircraft history and the Show/Hide/Clear History functions would complete the interface as originally

designed. In addition, there are numerous opportunities to improve troubleshooting capability, e.g. incorporation of the system Status Screen, a re-initialize capability for critical subsystems or the whole system, and potentially an operator-controlled Diagnostics State. Furthermore, a data capture and recording feature could be added to facilitate test and evaluation.

b) In the event that the ELVISS Prototype Workstation is to be operated or tested in areas other than the Ottawa/Gatineau region, that map files be generated for the new areas and integrated into the workstation. Otherwise, the operator will see only a black background in the moving map window.

c) The problem with getting colour NTSC output for the Windows desktop image be investigated further and resolved either by correcting the output at source (the Matrox Orion card), or by splitting the Video Graphics Accelerator (**VGA**) output and using an NTSC converter.

d) To improve the accuracy of the aircraft icon display and the relative angle of the camera footprint, aircraft heading data be taken from the Bell 412 aircraft computer, rather than the POS/AV Unit.

## 8 REFERENCED DOCUMENTS

Development of ELVISS Human-Machine Interface Concepts, Contract No. W7711-8-7457/001/SRV

ELVISS Human Engineering Design Approach Document - Operator, CMC Document Number 1000-1182, 28 April 1999.

ELVISS HFE Prototype Workstation System Interface Definition, Contract Serial No. W7711-9-7588/001/TOR

ELVISS Airborne HFE Prototype Workstation - Stage Definition Document Version 9, 27 September 2002.

# 9 ABBREVIATIONS, ACRONYMS, AND DEFINITIONS

| | |
|---|---|
| " | Inch |
| ° | Degree |
| AGL | Above Ground Level |
| AGTV | Active Gated TeleVision |
| ALBEDOS | Airborne Laser-Based Enhanced Detection and Observation System |
| ATN | Augmented Transition Network |
| BIT | Built-In-Test |
| CCG | 'C' Code Generator |
| CDRL | Contract Data Requirement List |
| CMC | CMC Electronics Inc. |
| DCIEM | Defence and Civil Institute of Environmental Medicine |
| DID | Data Item Description |
| DND | Department of National Defence |
| DREV | Defence Research Establishment Valcartier |
| DSS | Department of Supply and Services |
| DVCAM | Digital Video CAMera |
| ELVISS | Enhanced Low-light-level Visible and Infrared Surveillance System |
| EMI | Electro-Magnetic Interference |
| FLIR | Forward Looking InfraRed |
| FOV | Field of View |
| FRL | Flight Research Laboratory |
| GPS | Global Positioning System |
| GUI | Graphical User Interface |
| HEDAD-O | Human Engineering Design Approach Document – Operator |
| HFE | Human Factors Engineering |
| HMI | Human Machine Interface |
| Hz | Hertz |
| IMU | Inertial Measuring Unit |
| INS | Inertial Navigation System |
| IR | InfraRed |
| J | Joint |
| K | Thousand |
| LAN | Local Area Network |
| LRF | Laser Range Finder |

| | |
|---|---|
| MSL | Mean Sea Level |
| N | North |
| NRC | National Research Council |
| NTSC | National Television Standards Committee |
| PC | Personal Computer |
| POS/AV | Position and Orientation System/Avionics |
| SA | Scientific Authority |
| SAR | Search and Rescue |
| SOW | Statement of Work |
| TI | Thermal Imager |
| UDP | User Datagram Protocol |
| VAPS | Virtual Applications Builder |
| VGA | Video Graphics Accelerator |
| W | West |

# ANNEX A
# Start-up Procedure
# for the ELVISS Airborne HFE Prototype Workstation

# Start-up Procedure for the ELVISS Airborne HFE Prototype Workstation - Stage 2/3

A. Verify the following switch and enunciator settings:

1. Set Gyro switches to *Off* and *Cage*
2. Set Illuminator to *Safe* (LED is off)
3. Set Inhibit switch to *Off* (pulled out)
4. Set Rangefinder switches to *Safe* (LED is off) and *Manual*
5. Set Map switches to *Show* & *1:250K*, and set *Zoom* to full left position
6. Set all recessed power switches (operator control panel) to *Off*
7. Set Range Gate back-lit button to *Gated* (down or illuminated)
8. Set Illuminator Active/Passive switch to *Passive* (Joystick)
9. If the 16" turret hand controller is connected, set its power switch to *Off*

B. Apply power to the workstation. The switch is on the gray power bar mounted beneath the operator control panel, just forward of the operator's right knee-cap.

C. Select Viewsonic Monitor power *On*.

D. Select OMNIX Computer power *On*. (The spring-loaded power switch is protected behind a black cover on the computer face and must be depressed momentarily to start the computer and illuminate the computer LED).

E. Log in as Administrator (Currently, no password is required).

F. Apply 28 VDC power to the external subsystems by selecting the recessed MAIN power switch to *On*. Confirm that a green status light is illuminated on the back of the power supply unit (reflection is visible at front of rack, bottom right side).

G. Turn on Applanix POS/AV unit.

H. Turn on the Omnistar unit (set the toggle switch, at back of unit, to the right).

I. Turn on the Colour TV monitor (power button) and verify the channel setting is "*A*". The channel button (labeled A/B) is the first (i.e. top left) button in the row of six gray buttons. If the button is *out*, the channel is set to A (normally displays the Colour Day Camera image). If the button is *in*, the channel is set to B.

J. Turn on DVCAM video recorders, and load tape in each unit. Set each recorder to *Remote* mode using the *Local/Remote* switch.

K. (Lab only) Ensure that the turrets are clear of obstructions for pan and tilt operations.

L. Apply power to the 16" turret using the recessed 16" switch in the operator control panel.

M. Apply power to the 24" turret using the recessed 24" switch in the operator control panel.

N. Confirm the five status lights on the POS/AV unit are all green.

O. Start the ELVISS application software (double-click the ELVISS.exe shortcut on desktop), and monitor the status messages.

P. At the software prompt, set the Gyro Switch to *On*.

**CAUTION**: Do not use the Cage/Uncage switch. Except for maintenance, it should always be set to *Cage* position (laboratory only).

# ANNEX B
# Shutdown Procedure
# for the ELVISS Airborne HFE Prototype Workstation

# Shutdown Procedure for the ELVISS
# Airborne HFE Prototype Workstation - Stage 2/3

A. In the ELVISS System Menu, select the *Shutdown* option, and press <OK> in the dialog box. Monitor the status messages and watch for software prompts.

B. At the software prompt, set the Gyro Switch to *Off*.

C. Wait for the software prompt to continue the Shutdown Procedure.

D. Shutdown the ELVISS subsystems and workstation:

1. Remove power from the 24" Turret using the recessed 24" switch in the operator control panel.
2. At the software prompt, remove power from the 16" Turret using the recessed 16" switch in the operator control panel.
3. Turn off the DVCAM video recorders.
4. Turn off the Colour TV monitor.
5. Turn off the Omnistar unit (set the toggle switch, at back of unit, to the left).
6. Turn off the Applanix POS/AV unit.
7. Remove 28 VDC power to the external subsystems by setting the recessed MAIN power switch to *Off*.
8. Use the Windows Start Menu to shutdown the computer.
9. Turn off the Viewsonic flat panel monitor.
10. Remove all power from the workstation using the switch on the gray power bar mounted beneath the operator control panel.

# ANNEX C
# ELVISS Airborne HFE Prototype Workstation Menus

# ELVISS Airborne HFE Prototype Workstation Menus

## Operator Menu

AGTV ▸

TI ▸

Turret ▸

Rangefinder ▸

Overlay ▸

Tracker ▸

VCR ▸

System ▸

Mode: **STANDBY** / RUN

## AGTV Menu

CAMERA

Mode: **AUTO** / MAN

Gain (MCP): xx

Level (ALC): xx

Iris: 50%

Filter: **ON**/OFF

ILLUMINATOR

Pulse Width: 100 metres

Power Level: 75 %

## TI Menu

| | |
|---|---|
| Null Pixel: | **OFF**/RUN |
| Mode: | **AUTO** / MAN |
| Level: | xx |
| Gain: | xx |
| Polarity: | Black Hot |
| FOV: | Narrow |

## Turret Menu

| | |
|---|---|
| Stow: | **DEPLOY**/STOW |
| Slave Status: | **SLAVED**/16" ONLY/24" ONLY |
| 24" Turret | |
| Nullzero: | **OFF**/RUN |
| Zmult: | **ON**/OFF |
| Gain Pan: | 66 |
| Gain Tilt: | 61 |
| Dome: | ON/**OFF** |
| Pitch Offset: | xx |
| Roll Offset: | xx |
| 16" Turret | |
| Auto Null: | **OFF**/RUN |
| Null Pan: | xx |
| Null Tilt: | xx |
| Gain Pan: | xx |
| Gain Tilt: | xx |

## Rangefinder Menu

| | |
|---|---|
| Target: | **FIRST**/LAST |
| Min. Range: | 50 metres |

## Overlay Menu

AGTV

| | |
|---|---|
| Header: | **ON**/OFF |
| Crosshair: | **ON**/OFF |
| Zoom Box: | **ON**/OFF |

TI

| | |
|---|---|
| Header: | **ON**/OFF |
| Crosshair: | **ON**/OFF |
| Zoom Box: | **ON**/OFF |

## Tracker Menu

| | |
|---|---|
| Tracker Mode: | POSITION/**TARGET** |

Target Options

| | |
|---|---|
| Control Input: | **WKSTN**/REMOTE CONTROL |
| Acquis. Mode: | MOTION/**POSITION** |
| Track Mode: | CORR/**CENTROID**/SCENE |
| Window Size: | SMALL/**MED**/LARGE |

## System Menu

| | |
|---|---|
| State: | INIT/STDBY/**RUN**/SHUTDOWN/MAINT |

16" Boresight ▸

LRF Boresight ▸

# VCR Menu

All VCRs

| | |
|---|---|
| Record: | RECORD/**STOP** |

| | |
|---|---|
| VCR 1: | On |
| VCR 2: | Disconnected |
| VCR 3: | End of Tape |

NOTE: VCR status values are: (On, End of Tape, Disconnected)

# 16" Boresighting

*Use +/- Keys to move to next step.*

| | |
|---|---|
| **Step 1**: | Put TI in Narrow FOV |
| Step 2: | Match AGTV FOV to TI FOV |
| Step 3: | Aim 24" Turret to target using Joystick |
| Step 4: | Align 16" Turret to target using arrow keys |
| Step 5: | Exit procedure |

# LRF Boresighting

*Use +/- Keys to move to next step.*

| | |
|---|---|
| **Step 1**: | Put TI in Narrow FOV. |
| Step 2: | Aim TI at small isolated target using Joystick. |
| Step 3: | Trigger rangefinder. |
| Step 4: | If range seems correct for target, continue; else adjust turret aim, and go back to Step 3. |
| Step 5: | If target and cross-hair no longer align, move cross-hair to re-align using arrow keys |
| Step 6: | Exit procedure |

# ANNEX D
# Stage 2/3 Integration Test Plan (Prior to Ground Trials)

# Stage 2/3 Integration Test Plan (Prior to Ground Trials)

1. Verify previous functionality is still intact (after shared memory update)
   - all software processes startup correctly
   - AGTV and TI videos are presented
   - all 16" turret, TI and LRF functions are still working
   - sample functions are still working, e.g. state/mode changes, menu navigation

2. Verify that system software detects absence of subsystems (16" turret, TI, LRF) and continues operation without them

3. Test menu navigation in new menus
   - Autotracker
   - AGTV
   - Turret - 24" (a repeat)
   - LRF Boresighting
   - 16" Turret Boresighting

4. Test key repeat function

5. Test receipt of GPS time and presentation of time in map overlay

6. Test radar altitude simulator and presentation of altitude data in map overlay
   - AGL annotation when receiving simulated radar altitude data
   - ASL annotation when using GPS altitude data

7. Test LED operation on control panel
   - Illuminator Armed/Safe
   - LRF Armed/Safe
   - LRF MTI
   - Gate Range
   - Gate Width
   - Primary Window

8. Test integration of discrete AGTV control panel switches and presentation of feedback in menus/overlays (if applicable)
   - Extender
   - Continuous/Gated
   - Gain
   - Armed/Safe
   - Inhibit

9. Test integration of joystick switches and presentation of feedback in menus/overlays (if applicable)
   - Narrow/Wide
   - Active/Passive

10. Test integration of analog AGTV control panel switches and presentation of feedback in menus/overlays
    - Zoom
    - Focus

- Gate Range
- Gate Depth

11. Test integration of AGTV menu functions and presentation of feedback in menus/overlays
    - Mode
    - Gain
    - Level
    - Iris
    - Filter
    - Pulse Width
    - Power Level

12. Test integration of 24" turret menu controls and presentation of feedback in menus/overlays (if applicable)
    - Nullzero
    - Zmult
    - Gain Pan
    - Gain Tilt
    - Dome
    - Pitch Offset
    - Roll Offset

13. Test 24" turret steering
    - slave mode
    - 24" turret only mode
    - 16" turret only mode (verify no response)

14. Test time set function for DVCAM
    - at initialization
    - on menu selection of "Record"

15. Test correct initialization sequence for 24" turret & AGTV

16. Test correct shutdown sequence for 24" turret & AGTV

17. Test Target Designate function
    - creation of up to six freeze frames
    - calculation and storage of lat/long data for each target

18. Test Freeze Frame controls
    - show and hide function for individual freeze frames
    - display of lat/long data for freeze frames
    - clear function for individual freeze frames

19. Test tilt angle display

20. Test bearing angle display

21. Test range data display (estimated and measured)
    - numeric between videos

- length of camera vector

22. Test pan angle display on polar plot

23. Test Position Designate and AutoSlew functions

24. Test pan angle display on map (camera pointing angle vector relative to aircraft icon)

25. Test LRF Boresighting Menu & verify TI cursor moves

26. Test 16" Turret Boresighting Menu

27. Test Autotracker functions
    - menu settings
    - joystick trigger

28. Test ability to switch between two map scales
29. Test experimenter ability to hide and show moving map

30. Verify video outputs to DVCAMs
    - full screen
    - AGTV
    - TI

31. Test aircraft track history display

32. Verify ability to clear, show, hide aircraft track history

33. Test sensor search history display

34. Verify ability to clear, show, hide sensor search history

35. Test slaving of 16" turret in "Slaved" mode
    - enter/exit Slaved mode
    - verify two turrets are tracking together at short ranges and estimate latency
    - verify accuracy at long ranges (about 1 km)

36. Test the Stow function
    - the 16-inch gimbal has an automatic STOW function (the window of the gimbal should move up and look inside the gimbal towards the top; also the gimbal is locked in position)
    - the 24-inch gimbal should be positioned to +90 degrees in azimuth ( looking towards the helicopter; 0 degrees is when the system points towards the nose of the helicopter), and -90 degrees in elevation (towards the ground)

verify this occurs when entering Standby Mode, Shutdown and when requested from menu

# ANNEX E
# Test Plan - Ground Trial Changes

# Test Plan - Ground Trial Changes

| Test | Sequence | Modules | Processes |
|---|---|---|---|
| 1. Test the new Gyro Off utility program | 1 | GyroOff.cpp | GyroOff |
| 2. Verify status messages are readable in the command window during Startup and Shutdown. | 2 | All | sysmag, elviss_video |
| 3. Verify AGTV mode is displayed in the overlay | 2 | video_functions.cpp | elviss_video |
| 4. Test new rocker switches for the Range Gate and Range Width functions. | 2 | cerialbox.cpp, AGTV_menu.ATN | sysmag |
| 5. Check new range for AGTV Zoom (32-800) and watch for delay in switch activation. | 2 | cerialbox.cpp, turret24.cpp, video_functions.cpp | sysmag, elviss_video |
| 6. Verify the Laser Overtemp message is displayed, when necessary. | 2 | video_functions.cpp, turret24.cpp | elviss_video, sysmag |
| 7. Verify Autotrack trigger works with single activation. | 2 | autotrack.cpp | sysmag |
| 8. Test Re-Init of 16" turret. | 2 | sysmag.cpp, turret16.cpp | sysmag |
| 9. Verify the re-formatted Turret and Boresighting Menus do not flash when map moves. | 2 | 16"Boresight_menu.FRM LRF_boresight_menu.FRM, | elviss (VAPS) |
| 10. Map overlays flash off and on when map moves. | 3 | main.ATN, inp.FRM | elviss (VAPS) |
| 11. Verify the footprint overlay is adjusted for map zoom changes. | 3 | main.ATN | elviss (VAPS) |
| 12. Verify that the position and target icons are retained when switching between map scales. | 3 | main.ATN | elviss (VAPS) |
| 13. Verify that the 24" Turret Uncages during Initialization, and does not wait until ELVISS goes into Run mode. | 4 | turret24.cpp | sysmag |
| 14. Test 24" Stow | 4 | turret24.cpp | sysmag |
| 15. Test Autoslew function (default not implemented) | 4 | turret24.cpp | sysmag |
| 16. Test Position Tracking | 4 | turret24.cpp | sysmag |
| 17. Verify the target lat/long calculation (in POS/AV) is consistent and accurate with respect to the different modes: Laser input, RadAlt input and GPS input. Check that the pointing angle of the camera footprint overlay on the map matches the target data. While checking the POS/AV TRP message window, verify that the laser data 'valid' flag does not change unless ELVISS sends a new mode command. | 5 | posav_com2.cpp, posav_lan.cpp | sysmag |
| 18. After boresighting the two turrets, test to verify the alignment is not lost. | 6 | turret24.cpp, turret16.cpp, Boresight_menu.ATN | sysmag |

# ANNEX F
# Stage 1 Evaluation Results for the ELVISS Airborne HFE Prototype Workstation

# ELVISS AIRBORNE WORKSTATION PROJECT
# STAGE 1 EVALUATION RESULTS

**Conducted**: April 3-5, 2002
**CMC Evaluators**: Stefano Fortugno, Brian Neal, Rui Zhang, Ed Campbell
**Customer Evaluators**: Sharon McFadden (DCIEM), Denis Dubé (DREV), Vincent Larochelle (DREV), Gilbert Tardif (DREV)

| # | Comments/Deficiencies/Improvements | Priority | Status |
|---|---|---|---|
| 1 | Startup sequence needs to include software checks for critical switch settings, and not permit operation until these switches are set correctly. Specifically,<br>• the Gyro On/Off must be set to Off,<br>• the Cage/Uncage must be set to Uncage,<br>• the Illuminator Armed/Safe must be set to Safe, and<br>• the Rangefinder Armed/Safe must be set to Safe.<br>The startup sequence must stop if any one is not correct, advise the operator and wait until the operator either sets correctly or quits the program. | High | Done |
| 2 | The Illuminator Armed/Safe is a special case in that the workstation software cannot read the switch value directly. Therefore the 24" Turret/AGTV initialization process must query the illuminator (if possible) and proceed as per Comment 1 if the switch is not set correctly. If the Illuminator cannot be queried, we need to remind the operator to set the switch correctly and wait for the operator to confirm correct selection (or cancel startup) by pressing a specific button. | High | Done |
| 3 | The video overlay visibility varies with the background video brightness. Because we could not use the VAPS functionality for this part of the GUI, we were not able to use a text outlining or haloing feature to provide reliable text definition. Need to add a black background to text to ensure readability (unless we can get VAPS working with the video). | Med | Done as a solid block for the two headers |
| 4 | Larger font is preferred in the menus. | Low | Deferred |
| 5 | The outline box for the Primary window needs to be thicker to make it more distinct. | Med | Done |
| 6 | The update rate of the TI image (bottom video window) is too slow when everything else is running, i.e. moving map, menus, serial comms. This image requires an extra video processing step compared to the top window which has the video grabbed directly to the display. One option is to get the pseudocolor working so that the grab/display buffers can be monochrome instead of colour (the image size is four times as big when using colour, so the copy speed is degraded). | High | Done |
| 7 | The aircraft icon (map overlay) is not visible. On ELVISS, it appears as dotted lines, while on Athos it appears as solid lines. Check VAPS object and properties to see why the North arrow is OK, but the aircraft icon is not. Even so, the stick aircraft is not distinct enough when overlaid on the colour map. Need to fatten the graphic, i.e. thicker lines, and add a black outline. | High | Done |
| 8 | The North arrow, the altitude and the time displays need black outlines (or halos) to ensure they are distinct and visible on top of the colour map. | High | Done |
| 9 | Replace the AGL/ASL altitude annotation with "R" for Radar | Low | Deferred |

| # | Comments/Deficiencies/Improvements | Priority | Status |
|---|---|---|---|
| | altitude (AGL) and nothing for GPS altitude (ASL). | | |
| 10 | Overall runtime performance is slow. Give top priority to the video update rate and lowest priority to the moving map. That is, can slow down the update rate of position and heading data to the moving map (which causes it to redraw). Map needs to be clipped to minimum size needed to reduce file size. Should also try a black and white map, instead of colour, to check performance difference. Also, ensure the system response to operator inputs is timely (less than 1 second); otherwise the user presses keys twice or three times because they got no initial response. | High | Done |
| 11 | The TI video loses frames occasionally (even in the AGTV window which is grabbed directly to the screen). However, the video is OK when displayed on the monitor after going through the DVCAM Recorder. Tried grabbing after going through DVCAM, but this did not help. Need to investigate Matrox digitizer settings (dcf file) and see if it needs modification to better match the video signal. NOTE: The TI camera specification says the video is non-interlaced, but DREV got their camera setup to output interlaced video. | High | Done |
| 12 | The workstation display second video output to the DVCAM Recorder is not supplying video (checked with monitor). May need to setup the Matrox Orion card in order to have it send the second video output (Orion has two CRT controllers). When the NTSC video output is connected, we only see the AGTV window video i.e. only the raw video, no overlays, window borders etc. | Med | Done |
| 13 | The LRF maximum range setting should be in the startup file and set to 10,000 metres. | Med | Done |
| 14 | The lowest minimum range which the LRF can provide is 50 m, however, the interface only allows discrete values of 0, 100, 200, etc. Therefore, the GUI should show 50 m as the lowest setting, but the software will send 0 m for this value. Increments from the GUI minimum will be 50 m, 100m, 200m, etc (until hit the 500m step range), while the increments for the software command to the LRF will be 0 m, 100 m, 200 m, etc. | Med | Done |
| 15 | For the LRF modes, the Cont/Man switch will control firing modes which are only activated when the LRF fire button is pressed. In Manual mode, the LRF will send a single pulse. In Continuous mode, the LRF will send a pulse train at 1 Hz for a duration 30 seconds. The length of Continuous should be added to the startup file so DREV can edit it later. The software should never allow the setting to exceed two minutes, no matter what is in the startup file. The startup file needs a warning to this effect. Also, the software will have to track Continuous firing and ensure that it does not exceed 2 mins of pulse trains in a row due to repeated operator requests. The laser crystal may break if overdriven. This tracking will have to be flexible to cover the various cases, e.g. two 30-sec firings, then a 1 min break, then two more 30-sec firings, another 1 min break, etc may eventually exceed the 2 min limit.<br>NOTE: The Target Designate button will only trigger a single pulse, no matter what mode is set. | High | Done |
| 16 | LRF does not pulse at max rate of 1 Hz when everything else is running, e.g. moving map. Need to monitor when doing runtime performance improvements. | Med | Done |
| 17 | POS/AV data updates from ethernet are not needed at 200 Hz and | High | Done |

| # | Comments/Deficiencies/Improvements | Priority | Status |
|---|---|---|---|
| | we don't want to drive the moving map at full screen refresh rate anymore. Reduce POS/AV ethernet connection to 50 Hz. | | |
| 18 | POS/AV Com 2 does not provide valid data. Probably because the POS/AV is not yet receiving gimbal encoder data from the 24" turret. Check again when we have the cable to connect turret to POS/AV (Com 3 input). | High | Done |
| 19 | Turret menu is not visible. | High | Done |
| 21 | The current time display is missing on the map overlay. | Med | Done |
| 22 | Add a function in the Overlay Menu to hide or remove the moving map. Useful for experiments, decluttering and for performance testing. | Med | Done |
| 23 | Add a second map for the 1:50,000 map scale. If real one not available, emulate with larger scale by zooming times five. | High | Done |
| 24 | The camera footprint will be tiny on a large scale map. We will need to set a minimum size threshold and/or replace with a icon to indicate where it is centered but not imply accurate areas. | High | Done |
| 25 | Matrox and VAPS fonts do not match. Try to pick different VAPS font for map overlays that are closer to Matrox font. | Low | Done |
| 26 | LEDs need to be controlled by Cerial Box software (including the LRF Multiple Target Indicator (MTI) light). | High | Done |
| 27 | Startup file needs further parsing and usage. | High | Done |
| 28 | In the Standby Mode, there are some functions which should not be available to the operator. Need to identify and disable. | Med | Done |
| 29 | The rocker switches (Menu Adjust and AGTV Gain) should support an automatic repeat function, i.e. after 0.5 seconds, if the switch is still down, the Cerial Box software should resend the switch value. | Med | Done |
| 30 | The different range display modes were not shown because valid range data was not available (testing in the laboratory). Verify at next demo (at which the LRF is available) because a difference is needed between the display format of estimated data and accurate LRF range data. | High | Done |

# ANNEX G
# Evaluation Results from the Ground Trials

# ELVISS Evaluation Results from the Ground Test

**Conducted at:** Connaught Range (also partial run-through in the laboratory on Sep 16th)
**Date:** 17-18 September 2002
**Participants:** DRDC Valcartier: Vincent Larochelle, Gilbert Tardif, Luc Gauthier, Denis Dubé
CMC Electronics: Brian Neal, Rui Zhang, Stefano Fortugno

| Observation | Priority | Resolution | Status |
|---|---|---|---|
| 1. Status messages are hard to read in the command window, during Startup and Shutdown. | 4 | Need to be more concise, provide user-friendly formatting, remove debug statements, and slow down status message presentation long enough to read each one. | Done |
| 2. LRF is firing correctly, but range data is incorrect. Numbers are incorrect, and do not change after initial firing. | 1 | Diagnose and fix software problem with the interpretation of the LRF data. | Done |
| 3. When the LRF data is not available, the estimated range data is not always provided.<br>LRF data from a Manual (single) firing should be displayed for 3-4 seconds so the operator has time to read the value before it is replaced with an estimated value. | 1 | Clear LRF data when no longer valid, even if range estimation is not available (e.g. tilt angles too high). Leave range field blank (except for units), or show "invalid" message.<br>Note: Hold manual range data for 3-4 seconds before replacing with estimated range data. | Done |
| 4. TI Focus is too sensitive | 2 | Adjust scaling of switch inputs | Done |
| 5. TI starts up in Auto Mode and Mode display in the TI Menu is not displayed initially | 2 | Menu is connected to shared memory which seems to be getting initialized to zero, instead of the Auto value of "1". | Done |
| 6. The key repeat function is too slow | 2 | Shorten the delay before repeat function starts, and increase the repeat frequency. Note that the speed varies with system mode, i.e. faster in Standby when not processing the video data. | Done |
| 7. Critical status messages are not displayed by ELVISS, e.g. Laser Overtemp.<br><br>Currently relying on the backup monitor (which has separate video displays with subsystem-specific overlays) for such messages as the Laser Overtemp warning. Also a few messages which ELVISS provides are not always reliable because there is no feedback from the subsystem, such as "uncaging" and "braking" from the 24" turret. | 1 | Identify critical messages and present as an overlay in lower AGTV window (just above polar plot area). Non-critical status messages usually already have a designated display area, e.g. DVCAM menu. Also, detailed error messages are sometimes displayed in the DOS-command window (under the application) for use in troubleshooting, e.g. "LRF message header invalid".<br><br>The 24" turret startup and shutdown messages are emulated based on a timer for when things should be happening in the normal sequence. Most of these messages are not available over the serial interface so ELVISS cannot tell exactly when these | Done |

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| | | changes occur. Although it may be possible to feed the AGTV 'overlay' video to ELVISS with the overlays hidden, but still see these status messages, this would mean the full overlays would not be available on the backup monitor. May have to rely on the backup monitor for the 24" turret startup/shutdown messages. | |
| 8. The target lat/long should be displayed with N/S and E/W suffixes, rather than using negative numbers for West and South. | 2 | Modify display format. | Done |
| 9. Target bearing readout is not accurate. | 1 | Diagnose and fix software calculation of value. | Done |
| 10. The target lat/long calculation (in POS/AV) does not seem to be consistent and accurate with respect to the different modes: Laser input, RadAlt input and GPS input. While checking the POS/AV TRP message window, the laser data 'valid' flag kept cycling on and off, even though the laser was not firing. If laser was off, the range value was zero. | 1 | Verify that ELVISS is correctly sending Laser data, RadAlt data and status flags (e.g. Laser valid, RadAlt valid, neither). | Test data recorded for analysis and problem resolved. |
| 11. FOV Header does not always change when Narrow/Wide switch is toggled. | 1 | ELVISS header is consistent with AGTV overlay, therefore no software change required. | INO issue. |
| 12. Gated/Cont switch is reversed. | 1 | Modify software | Done |
| 13. Cannot put AGTV in Passive while in Continuous. | 1 | Verify with original console. | Done |
| 14. Zmult does not seem to be working. | 1 | Talk to Wescam. | Wescam issue |
| 15. AGTV Zoom switch has a delay before the zoom function starts to work. | 3 | Check update rate of AGTV commands and optimize if possible. | Deferred |
| 16. Response time for changing Range Gate and Range Width. | 2 | Replace slider switches with rocker switches so that the hardware input is better matched to the software controls available. | DREV and CMC issue |
| 17. Status overlay for Autotrack Mode does not match Autotrack Mode when Autotracker loses 'track'., then gets out of synch. | 1 | Check for lost track situation and refresh the display feedback message. | Done |
| 18. Sometimes have to select Autotrack trigger twice before the Autotracker toggles On/Off. | 3 | Check software and re-test. | Deferred |
| 19. The Mode or Status Pages sometimes appear at startup on the AGTV video (going to | 1 | Modify initialization code to command 24" turret to hide mode and status pages. | Done |

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| the backup monitor). The Mode page prevents the Zoom function from working and both pages hide the startup status messages. | | | |
| 20. Increments for 16" Turret boresighting are too sensitive. | 2 | Decrease increments. | Done |
| 21. Autoslew and the 24" Stow function are not accurate. | 1 | Software interface to 24" turret uses pan encoder angle for command input, but turret pan angle (or azimuth) is the sum of pan encoder angle, pan offset and roll angle. Status message from 24' turret is turret azimuth so the control loop is not manageable. Discuss options with Wescam. | CMC and Wescam issue |
| 22. Default Autoslew to nose of aircraft (when no recent Position Designated) not implemented. | 4 | Add code to keep track of when to use default. When Position Designate button is pressed, set flag to POSITION_SLEW. When AutoSlew is pressed, check flag first. If set to POSITION_SLEW, slew to position, then reset flag to DEFAULT. If flag set to DEFAULT, slew to nose. | Deferred |
| 23. The aircraft appeared in the right spot on the map on startup, but the map did not move when the test platform moved. | 1 | Verify the threshold code (how far the airplane must move before the map is re-drawn) and adapt to the different map scales. | Done |
| 24. Map overlays flash off and on when map moves. | 3 | Try different overlay setup in VAPS application. | Done |
| 25. Turret Menu flashes off and on when map moves. | 2 | Reformat to fit below the map window. | Done |
| 26. Footprint overlay is not adjusted for map zoom changes. | 2 | Add code to check and account for zoom value. | Deferred |
| 27. 16" Turret should stow automatically when TI Autonull is requested. | 2 | Have TI code alert turret code to stow before Autonull, then unstow after. | Done |
| 28. RadAlt data is not received by ELVISS, or displayed on map (AGL values). | 1 | Verify simulated input of RadAlt data is received and correctly displayed on the ELVISS display. | Done |
| 29. The zero position of the turrets is not correct for mounting on the aircraft. | 1 | Reset pan and tilt offsets. | Done |
| 30. The heading of the aircraft icon was not always accurate, and sometimes appeared to be 180 degrees off. | 2 | Check code and re-test.<br>After re-testing, the heading angle seemed fine, although it is slow to update. The POS/AV needs sufficient motion to determine heading accurately. It should update faster and be more accurate when moving at aircraft speeds. | Done |
| 31. AGTV illuminator is not aligned with camera. | 1 | Hardware fix. | DREV issue |
| 32. The label on the desktop shortcut icon is ambiguous. | 2 | Re-name to "ELVISS" | Done |
| 33. Once set on, the MTI LED | 1 | Check code to ensure correct re-set, | Done |

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| never went off. | | especially when LRF range response is invalid, i.e. turn off MTI anyway. | |
| 34. The 16" and LRF boresight offsets should be saved and available for use on next startup. | 2 | Save offsets to file and load previous values during Initialization. | Done |
| 35. The Initialize State causes the application to completely shutdown, before re-starting. It looks as if the re-start gets out of synch with the shutdown with respect to Gyro On/Off for the 24" Turret. | 3 | Long-term: Modify initialization sequence and restrict activities to close/re-open ports, re-setting parameters, etc.<br><br>Short-term: Inhibit operator access to Re-Init function. Provide dialog box to explain it is not available. | Done (short-term only) |
| 36. The 24" Turret does not Uncage until ELVISS goes into Run mode. | 1 | The problem seemed to go away after Item 19 was fixed (hiding the Mode page during Initialization). Monitor. | Done |
| 37. The pointing angle of the camera footprint overlay on the map was inaccurate. | 1 | Further testing verified that the pointing angle was correct for the target reference position data being received from the POS/AV. The resolution of item 10 will also correct this item. | As per Item 10 |
| 38. The Rapid Erect function was not working. | 1 | Further testing verified this function was working in Run mode. It is not available in Standby mode. Also, re-seating the EPROM chip in the 24" turret may have contributed. | Done |
| 39. The AGTV sometimes started in Active mode. | 1 | This occurred after Item 12 was fixed. There is an inter-relationship between the Gated/Continuous Switch and the Active/Passive Switch. The startup procedure was modified so that the Gated/Continuous Switch must be in Gated mode (depressed) during initialization so that the workstation software can command the AGTV to go to Passive mode. | Done |
| 40. When switching between map scales, the position and target icons are lost. | 3 | When the map is changed, re-load the current icons and position according to the current scale. | Done |
| 41. The Iris setting is reversed from the values in the AGTV Menu. | 1 | Reverse the AGTV commands so that 0% is fully closed and 100% is fully open. | Done |
| 42. After boresighting the two turrets, the alignment seemed to wander when steering to the left, and then recover after steering to the right. | 1 | Verify the offsets being used are stable. Further testing with the optimized boresighting increments (Item 20) was successful when the boresight target was at a sufficient viewing distance. Depending on how close the boresighting target is and on how far away the imagery is during testing, the turret slaving will be more or less sensitive to parallax errors induced by the physical geometry of having the cameras in different turrets. The slaving error which occurred when panning left was probably the result of the new direction being looked relative to the | Done |

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| | | original boresighting angle, rather than the movement itself. | |
| 43. Ground test changes have not been captured | 1 | Check in all modified files and label as Release 2/3.<br>Also, back up on CD-ROM disk. | Done |

# ANNEX H
# Flight Trial Evaluation Results for the ELVISS Airborne HFE Prototype Workstation

# FLIGHT TRIAL EVALUATION RESULTS FOR THE ELVISS AIRBORNE HFE PROTOTYPE WORKSTATION

**Conducted**: October 21-31, 2002
**Customer Evaluators**: Sharon McFadden (DRDC), Jacqui Crebolder (DRDC), Denis Dubé (DRDC), Vincent Larochelle (DRDC, Luc Gauthier (DRDC), Gilbert Tardif (DRDC)

**NOTE**: CMC was not involved in all Flight Trial tests. This summary of evaluation results in not necessarily all-inclusive, rather it includes items which were reported to CMC by DRDC evaluators or noticed by CMC directly. Also, the Priority values were assigned subjectively from CMC's perspective in the context of identifying whether a resolution was needed during the Flight Trials. For example, the ergonomics item (# 6) is listed as Low because it was not practical to make the major changes needed to improve the installed workstation configuration during the Flight Trials. In the medium to long term, this item would obviously be High Priority.

| # | Comments/Deficiencies/Improvements | Priority | Status |
|---|---|---|---|
| 1 | With the original startup sequence, the initialization of the 16" Turret took place after the 24" Turret. If the 16" Turret failed to initialize and re-start was necessary, the operator had already waited through the 2 minute gyro spin-up process and would now have to wait again for the gyros to stop. To avoid unnecessary waiting time, the startup sequence should reverse the order of turret intialization so the operator can abort on detecting a 16" Turret failure, without having to go through 24" Turret initialization.<br><br>Also, it was recommended by Applanix that the two turrets be positioned at the zero/zero reference configuration while POS/AV is performing its Nav Align function. The ELVISS Prototype Workstation startup sequence needs to be modified to coordinate these activities. | High | Done |
| 2 | The NTSC desktop video provided for recording was not in colour as expected. Although Matrox provided a software fix, this only worked when the Orion graphics received the AGTV video input with a colour burst signal. A direct connection of the RS170 signal from the AGTV seemed to force the Orion card into monochrome NTSC output mode. However when the AGTV signal was fed through the DVCAM Recorder before going into the Orion card, the NTSC output switched into colour mode. **Note**: if the DVCAM is Off, the video signal is automatically passed through. However when the DVCAM is On, the Recorder must be in either Record or 'fake' Record mode to pass the video signal through. | High | A workaround was setup whereby the AGTV video was passed through a DVCAM Recorder which was put into 'fake' Record mode in order to forward the signal onto to the Orion card with a colour burst signal component. |
| 3 | Heading accuracy was still a problem during the Flight Trials. The accuracy of the heading information is highly dependent on motion of the GPS antenna because the heading is calculated by plotting a course through the most recent aircraft position fixes. This works well for fast jets, but if the platform is stationary or moving slowly (especially in a hover), the estimated heading will often be wrong and the error can be very high. | High | Deferred |
| 4 | The Bell412 Radar Altimeter is not accurate at heights greater | Med | Done |

| # | Comments/Deficiencies/Improvements | Priority | Status |
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| | than about 1500 feet above ground level (AGL). Also the radar altitude output can be negative when the aircraft is on, or very close to, the ground. The ELVISS Prototype Workstation should use GPS altitude when the Radar Altimeter data input exceeds 1500 feet, and display zero when the radar altitude input is negative. | | |
| 5 | The two turrets were physically mounted close together, but there was still a lateral separation of several feet between the two turrets. Turret offsets for pan and tilt were adjusted so that the two turrets would have the same zero/zero reference orientation for pan and tilt angles. This however points the sensors parallel to each other so a software alignment feature was provided to pull the 16" turret off the parallel axes to align with the 24" turret sensors. This feature is good for a limited range of viewing angles and depth of field, but has a variable error outside of the region used for the software boresighting procedure. See 2.3.16 for details.<br>The main result was that during flight, the TI image could not be accurately aligned with the AGTV image, and the TI image was always moving relative to the AGTV image. | High | Done, in that all optimizations that were feasible at the time were performed. The ultimate resolution is the future integration of all sensors into one turret under the SPARTACUS Program. |
| 6 | Although the orientation of the workstation was excellent because the operators were facing forward - the same as the pilots and in the same direction as the reference position of the sensors, the ergonomics of this temporary aircraft installation set-up were poor. Specific problems included:<br>• seat height was too low relative to the control panel, as well as to the monitor, affecting comfortable reach and viewing angles<br>• the height of the joystick above the control panel, in combination with the low seat height, caused arm fatigue (a foam armrest was added for the last flights)<br>• the trackball position was awkward to reach and use, especially for right-handers<br>• a jump seat (which is not intended for operators) was used for the workstation<br>• a circuit breaker panel protruded behind the operator (in place of a backrest) | Low | Deferred |
| 7 | Viewing angle restrictions for the two turret configuration were identified. See 2.3.21 for details. | N/A | N/A |
| 8 | The Illuminator FOV setting was reversed from the Joystick switch setting and header overlay value. | High | Done. The two FOV values were reversed within the ELVISS Prototype Workstation software. |
| 9 | After the colour NTSC Output problem was fixed, anomalies appeared which affected the clearing of some status data and graphic overlays, i.e. when they were redrawn to show new values, the old value were still visible in a shade of grey. | Med | Done |
| 10 | TI Focus was too sensitivity, particularly for Narrow FOV; need | High | Done. The scale |

| # | Comments/Deficiencies/Improvements | Priority | Status |
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| | to reduce sensitivity and have a different scale factor for Narrow FOV. | | factor for the focus command was modified and made dependent on the current FOV. |
| 11 | The AGTV Gain rocker switch was not needed as much by the Flight Test operators as was the AGTV Illuminator Pulse Width control. | | Done. The AGTV Gain rocker switch was re-allocated to the Illuminator PW for the Flight Trials. |
| 12 | Trackball vibration periodically caused the cursor to drift down to the Windows Task Bar which was set to Auto-Hide. This caused the Task Bar to pop-up and hide the bottom of the ELVISS Operator Interface, including the TI status data. | High | Done. Auto-Hide feature was turned off. |
| 13 | The Autotracker Acquisition Gate was sometimes offset from centre. The Autotracker reset function re-centred the gate overlay, but the ELVISS Workstation lost connection. | Med | CMC verified that the ELVISS Prototype Workstation software was not controlling the gate position. A future resolution could involve including a re-initialization feature in the ELVISS Prototype Workstation so it controls the reset function. |

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14. ABSTRACT

(U) This report was prepared in support of the ELVISS Airborne HFE Prototype Workstation Project. This project was sponsored by DRDC Valcartier as part of a larger program to develop the Enhanced Low-light-level Visible and Infrared Surveillance System (ELVISS). The original Human Factors Engineering (HFE) rapid prototype, which was developed as part of an earlier tasking to CMC Electronics, used simple simulations of the sensor equipment to facilitate operator evaluation in a laboratory environment of the new Human Machine Interface (HMI). The primary objective of the current project is to convert the laboratory prototype into a flyable prototype workstation which could control the real equipment and be operated by Search And Rescue (SAR) Technicians under experimental flight test conditions.
The work related to the integration of the ELVISS Airborne HFE Prototype Workstation software with the various ELVISS subsystems is documented in this report, along with the results of the Ground and Flight Test activities which were carried out to further demonstrate and evaluate the system's potential to support SAR operations.

(U) Le présent rapport est conçu pour appuyer le projet de poste de travail prototype IFE aéroporté du système ELVISS. Le projet a été parrainé par RDDC Valcartier dans le cadre d'un programme plus vaste qui consistait à réaliser le système de surveillance multicapteurs amélioré combinant une caméra visible à faible luminosité et une caméra thermique (ELVISS, pour Enhanced Low-light-level Visible and Infrared Surveillance System). Le premier prototype ergonomique rapide, réalisé grâce à des travaux confiés antérieurement à CMC Electronics, utilisait de simples simulations de l'équipement de surveillance pour faciliter l'évaluation par l'opérateur dans les conditions d'essai en laboratoire de l'interface homme-machine (IHM). L'objectif principal du projet actuel est de convertir le prototype de laboratoire en un poste de travail prototype aéroportable qui pourrait contrôler l'équipement réel et que les techniciens de la recherche et sauvetage (SAR) pourrait utiliser dans des conditions d'essais expérimentaux en vol.

Les travaux liés à l'intégration logicielle du poste de travail prototype d'IFH) aéroporté ELVISS aux divers sous-systèmes d'ELVISS sont documentés dans le présent rapport. Y sont aussi indiqués les résultats des activités d'essais en vol et au sol qui ont été entreprises afin de démonter et d'évaluer la capacité du système de soutenir les opérations de SAR.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) Enhanced low-light level visual and infrared surveillance system; ELVISS; AGTV; thermal infrared; Human Factors Engineering; prototype; display; workstation; human-machine interface; search and rescue; evaluation; laser range-gated; active imaging